TM 11-1547A

WAR DEPARTMENT TECHNICAL MANUAL

G9

RADIO SET AN/TPS-1A

SERVICE MANUAL

THEORY, TROUBLE SHOOTING, AND REPAIR

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RADIO SET AN/TPS-1A

SERVICE MANUAL

THEORY, TROUBLE SHOOTING, AND REPAIR

WAR DEPARTMENT *29 SEPTEMBER 1944*

WAR DEPARTMENT,
WASHINGTON 25, D.C., 29 SEPTEMBER 1944.

TM 11-1547A, Radio Set AN/TPS-1A, Service Manual, is published for the information and guidance of all concerned.

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Chief of Staff.

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(For explanation of symbols see FM 21-6.)

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DESTRUCTION NOTICE

WHY — To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN — When ordered by your commander.

HOW — 1. Smash — Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut — Use axes, handaxes, machetes.

3. Burn — Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives — Use firearms, grenades, TNT.

5. Disposal — Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT

WHAT — 1. Smash — all vacuum tubes, controls, dials, transformers, resistor boards, resistors, capacitors, etc.

2. Cut — all cables and wires.

3. Burn — all of the above equipment, training manuals, etc.

4. Bury or scatter — any or all of the pieces mentioned above, after destroying them.

DESTROY EVERYTHING

WARNING

HIGH VOLTAGE

is used in the operation
of this equipment.

DEATH ON CONTACT

may result if personnel fail
to observe safety precautions.

Be careful not to contact high-voltage plate circuits or 115-volt a-c input connections while checking or servicing the equipment. Make certain that the power is turned off before disassembling any part of the equipment.

Dangerously high voltages are present in the power supplies of this equipment. High-voltage capacitors in these power supplies must be discharged manually when service checks are made after the a-c power has been removed from the components.

EXTREMELY DANGEROUS POTENTIALS

exist in the following units:

Modulator Unit MD-2/TPS-1

Radio-Frequency Unit RF-1/TPS-1

Indicator Unit ID-16/TPS-1A

Power Unit PU-6/TPS-1

FIRST AID TREATMENT FOR ELECTRIC SHOCK

I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

Shut off the current. If this is not immediately possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.

RESUSCITATION

POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm, so that the nose and mouth are free for breathing (fig. A).

2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.

3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B). Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).

6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up for hours.

8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.

9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.

10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.

11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

REFERENCE NOTICE

TM 11-1547A, SERVICE MANUAL, is one of three technical manuals on Radio Set AN/TPS-1A. It is used in conjunction with TM 11-1347A, TECHNICAL OPERATION MANUAL, and TM 11-1447A, PREVENTIVE MAINTENANCE MANUAL. TM 11-1547A contains two general types of information. First, it explains the theory of operation of Radio Set AN/TPS-1A; and second, it supplies practical procedures to be followed when the equipment fails to function properly. The SERVICE MANUAL serves as a guide for locating the source of trouble, indicates the proper repair or replacement necessary, and in general assists the technician in charge to get the radar set back into service.

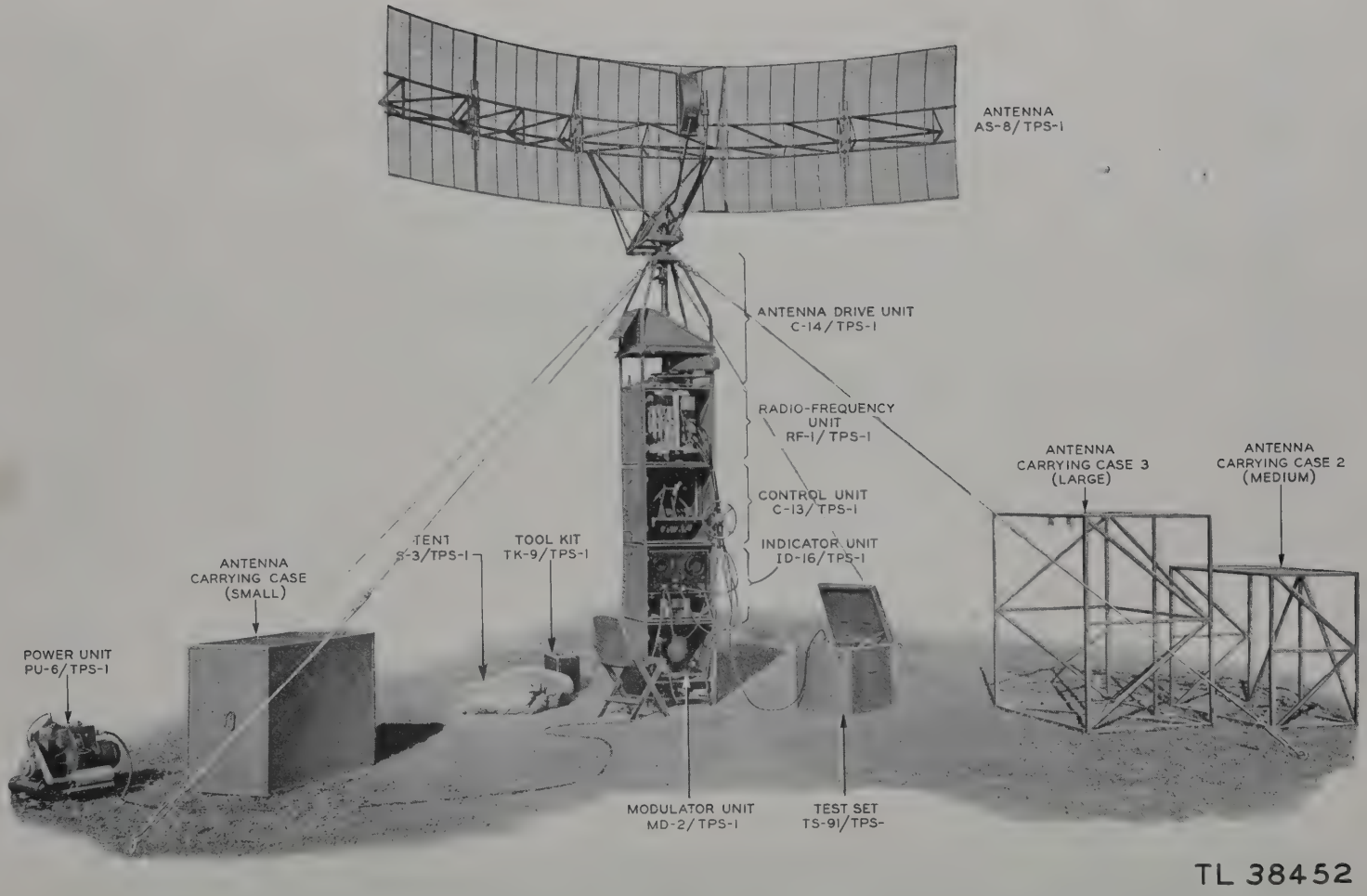

Figure 1. Radio Set AN/TPS-1A.

This manual, together with TM 11-1347A and TM 11-1447A, supersedes TM 11-1147, 15 December 1943, and Supplement TM 11-1147, 15 March 1944.

CHAPTER 1
THEORY

SECTION I
ELEMENTARY PRINCIPLES

1. FUNDAMENTALS OF RADAR.

a. Basic Principle. The basic principle of radar is the fact that high-frequency radio waves, although they cannot be seen with the eyes, travel in straight lines like light and are reflected from certain objects much as light is. The reflected waves can be recorded by suitable apparatus, and thus the presence of the object from which they were reflected can be detected, although the object itself cannot be seen. Also, since the waves travel with the speed of light (186,000 miles per second), the distance of the object from the observer can be calculated accurately, provided the time required for the waves to travel from the observer to the object and back again is measured. Because of the high speed at which the waves travel, this time is extremely short (about 1/10,000 second for an object 10 miles away), but means are available for measuring it. By forming the outgoing radio waves into a narrow beam, the direction of the object can also be determined with fair accuracy, since the waves are reflected only when the beam is directed at the object.

b. Pulse Transmission. The transmitter sends out short bursts or pulses of radio-frequency (r-f) energy. When this energy strikes a target, part of the energy is reflected and is returned to the radar set. If the transmitter is turned off before the reflected energy, or echo, returns from the target, the radar set distinguishes between the transmitted pulse and the reflected pulse (echo). After all reflections have returned, the transmitter is again turned on and the cycle repeated. Sufficient time must be allowed between transmitted pulses for an echo to return from any target within the maximum workable range of the radar set. In Radio Set AN/TPS-1A the pulses are sent out about 400 times a second. Each pulse of high-frequency energy lasts only about 2 microseconds, leaving "silent" periods of some 2,500 microseconds during which the reflected waves may be received. This is more than twice the time required for the waves to return from objects at the extreme range of the equipment. Each pulse is at a very high level of power, but, because the pulses are so short and so comparatively far apart, the total power consumed is not great and small apparatus can be used.

(1) PULSE WIDTH. The duration of each transmitted pulse is commonly referred to as *pulse width*. The minimum range at which a target can be detected is determined largely by the width of the transmitted pulse. If a target is so close to the transmitter that the echo is returned to the radar set before the transmitter is turned off, the reception of the echo is masked by the transmitted pulse.

(2) PULSE-REPETITION (RECURRENCE) FREQUENCY. The desired maximum workable range of the system determines the minimum elapsed time between successive pulses as explained above. The number of pulses transmitted per second, which is determined by the time elapsed between successive pulses, is called the *pulse-repetition frequency*.

c. Antenna Directivity. The radar antenna must be directional; that is, it must be constructed so that the radio-frequency energy is transmitted in a concentrated beam. Otherwise

targets at several directions from the antenna would return echoes for a single transmitted pulse, and there would be no means of determining the directions of the various targets. The antenna must be rotatable so that the operator can control the direction in which the energy is being sent out.

(1) A single radiating element (a dipole) sends out more energy in some directions than in others. A system of reflectors further concentrates the energy. These principles are utilized in the construction of radar antennas to produce a single, unidirectional, narrow beam of energy. The pattern produced in this manner permits the beaming of maximum energy in the desired direction.

(2) The transmitting pattern of an antenna system is the same as the receiving pattern (fig. 2). One antenna, therefore, can be used both to transmit and to receive energy effectively.

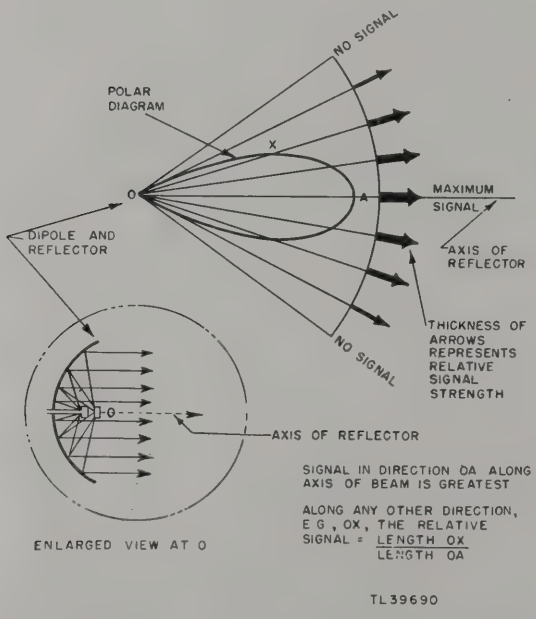

Figure 2. Horizontal antenna pattern.

d. Determination of Azimuth or Bearing. The measurement of the direction of a target from the radar system is usually given as an angular position, measured from some reference direction. The angle at which the echo signal returns can be measured because of the directional beam characteristics of the radar antenna system. The antenna rotates in azimuth, directing energy over the region to be searched. Reflected energy is received from the target through a sector of angular positions of the antenna. In the position in which maximum reflected energy is received, the antenna points directly at the target, and the position of the antenna is an indication of the azimuth or bearing of the target.

(1) Figure 3 shows the receiving (or transmitting) pattern for a typical radar antenna system. The relative signal strength is shown plotted against the angular position of the antenna with respect to the target. Maximum energy is transmitted to the target or received from the target only when the axis of the lobe passes through the target.

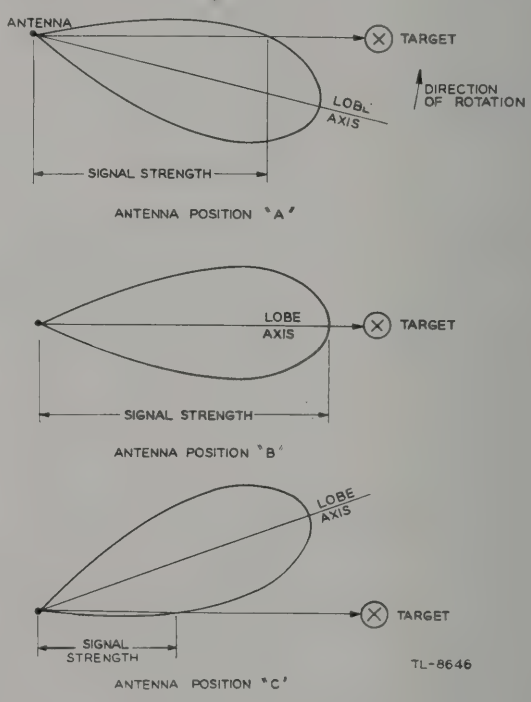

Figure 3. Variation of signal strength with antenna direction.

(2) The accuracy with which the direction of a target can be determined depends on the angular width of the lobe pattern. If the signal strength changes rapidly when the antenna is rotated a small amount in either direction from the on-target position, the on-target position can be selected with a greater degree of accuracy.

e. Determination of Range. The measurement of range depends upon a conversion from time to distance which is possible because of the known velocity of radio waves.

(1) Radio-frequency energy which has been radiated into space travels at a known constant velocity. When the energy strikes a reflecting object there is no loss of time. The reflected energy is redirected and continues to travel at the same constant velocity. Its velocity is the same as that of light, 186,000 land miles per second or 0.186 miles per microsecond (millionth of a second).

(2) The radar system measures range by measuring the time required for a pulse of energy to travel to a target and return. For example, assume that a 1-microsecond pulse is transmitted toward an object which is 18.6 miles away. When the pulse reaches the target, it has traveled 18.6 miles at 0.186 miles per microsecond, and therefore 100 microseconds have elapsed. The pulse is then reflected, and energy is returned over the same path. Since the return trip is also 18.6 miles, it takes 100 microseconds for the reflected pulse to return to the radar set. The total elapsed time is 200 microseconds, but the total distance traveled is twice the actual range of the target. Since it is desired to know only the range of the target, the velocity is commonly considered to be one-half of its true value, or 0.093 mile per microsecond. In this example, range = time x 0.093 = 200 x 0.093 = 18.6 miles.

f. Determination of Time. In order to utilize the time-range relationship discussed in subparagraph e above, the radar system must have a time-measuring device. In addition, since there may be more than one target in the region being searched, some means of separating and identifying pulses must be provided. The cathode-ray oscilloscope is well suited to such a task, because it not only retains the information on its screen but also provides a time scale. The time scale is produced by using a linear sweep to produce a known rate of motion of the electron beam across the screen of the cathode-ray tube.

(1) The measurement of time is illustrated in the following example: Assume that a cathode-ray tube is used with a radial linear sweep which produces a beam whose velocity across the screen is 1 inch per 100 microseconds. The echo signals received from a target at a range of 18.6 miles are applied to the oscilloscope as a brightening of a point on the sweep. Following the same sequence of events as discussed in subparagraph e(2) above, figure 4[1] illustrates the radio-frequency pulse leaving the radar antenna and the horizontal sweep just starting across the screen. Since 1 microsecond has elapsed, the leading edge of the pulse has moved 0.093 mile from the antenna, and the sweep trace has moved 0.01 inch across the screen. The receiver detects the transmitted pulse, which shows on the screen of the oscilloscope as a bright spot. Fifty microseconds after being generated, the transmitted pulse has traveled half the distance to the target, and the sweep trace has moved 1/2 inch (fig. 4[2]). After 100 microseconds have elapsed the pulse reaches the target 18.6 miles away (fig. 4[3]), and the sweep trace has moved 1 inch. The reflected pulse returns to the radar antenna 100 microseconds later. Figure 4[4] shows the reflected pulse halfway back to the antenna, and figure 4[5] shows the reflected pulse and the sweep trace at the time that the pulse arrives at the antenna. A total time of 200 microseconds has elapsed from the time the transmitted pulse was sent out. During this 200-microsecond period the sweep trace has moved a total distance of 2 inches. For a distance representing the duration of the received pulse (1 microsecond) the trace on the face of the oscilloscope is brightened. Thus, with a constant sweep-trace velocity of 1 inch per 100 microseconds, a time scale is produced which is equivalent to 100 microseconds per inch times 0.093 mile per microsecond or 9.3 miles per inch of trace. If another target returned the transmitted pulse in 300 microseconds, the return signal would be indicated 3 inches from the start of the sweep, and the range of this target would be 300 x 0.093 = 27.9 miles.

(2) The single sweep trace described in the above illustration persists on the oscilloscope for only a short time. It is therefore necessary to repeat the pulse transmission and the sweep trace periodically. If the two operations are correctly synchronized, signals returned from the same target will be shown at the same range by successive sweep traces. The echo signals from all targets will be shown on the oscilloscope in their proper range positions.

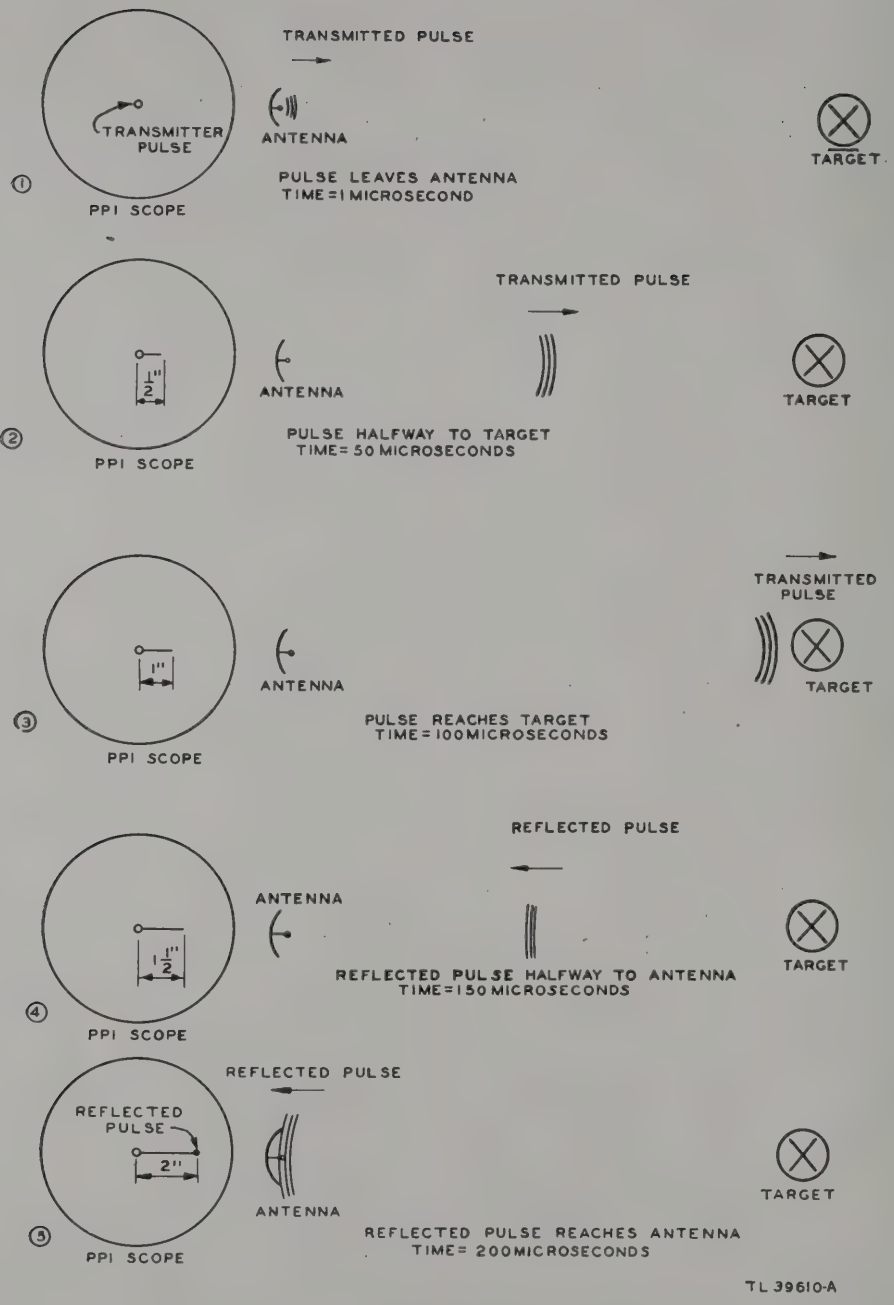

Figure 4. Measurement of time with PPI oscilloscope.

2. GENERAL DESCRIPTION OF RADIO SET AN/TPS-1A.

a. Radio Set AN/TPS-1A is a portable ground-based search radar for the detection of aircraft at ranges up to 100 miles. It furnishes range data in statute miles and azimuth data in degrees. It does not furnish elevation information. The equipment in operating condition is shown in figure 1.

b. The apparatus is contained in weatherproof plywood cases which fit together to form a tower for the antenna. Connections between the units are made by cables which plug into receptacles on the faces of the units.

c. A vacuum-tube modulator, with the high-voltage parts immersed in oil, supplies pulses to a magnetron oscillator, thus producing the radio energy. This is transmitted over a coaxial transmission line with a flexible section to a parabolic projector and reflected in a beam by a wire mesh antenna of parabolic form. The antenna may be rotated by hand or by motor but cannot be tilted.

d. The receiving system takes r-f energy from a transmit-receive (T-R) box on the coaxial transmission line. From the T-R box the reflected energy is transmitted to two r-f preamplifiers and a mixer supplied with beat frequency by a beat oscillator (local oscillator). The preamplifier, mixer, and beat oscillator tubes are of the type employing mechanically tuned cavities. The intermediate frequency at 60 megacycles is amplified in four stages and detected in an i-f amplifier assembly.

e. Target indications are displayed on a 7-inch PPI oscilloscope and a 5-inch Class A oscilloscope. Sweeps for the two oscilloscopes are synchronized with the transmitted pulse by a pulse from the transmitter system. Both oscilloscopes are provided with range markers and the PPI oscilloscope has an azimuth scale. The ranges provided are 20 and 100 miles on the Class A oscilloscope and 20 and 60 miles on the PPI oscilloscope.

f. Provision is made for the connection of IFF equipment which is not furnished with the radio set.

g. Power is supplied by a separate power unit with an air-cooled two-cycle gasoline engine. The power requirements are 1,100 watts at 115 volts, 400 cycles, and 180 watts at 27 volts direct current.

h. Seven multiconductor cables are provided

TABLE I. CONNECTING CABLES SUPPLIED WITH RADIO SET AN/TPS-1A

Color code	*Purpose*	*Approx length (feet)*	*Designation*
Blue	Connects power plant to Indicator Unit ID-16/TPS-1A.	50	Cord CX-69/TPS-1
Green	Connects beat oscillator in indicator unit to modulator in Radio-Frequency Unit RF-1/TPS-1.	8	Cord CG-39/TPS-1
Orange	Connects power circuits between indicator unit and radio-frequency unit.	7	Cord CX-71/TPS-1
Red	Connects power circuits between Modulator Unit MD-2/TPS-1 and radio-frequency unit.	10	Cord CX-70/TPS-1
Silver	Connects pulse circuit between modulator unit and radio-frequency unit.	12	Cord CG-40/TPS-1
White	Connects power circuits between radio-frequency unit and Drive Unit C-14/TPS-1.	3	Cord CX-72/TPS-1
Yellow	Connects mixer to indicator unit.	8	Cord CG-38/TPS-1

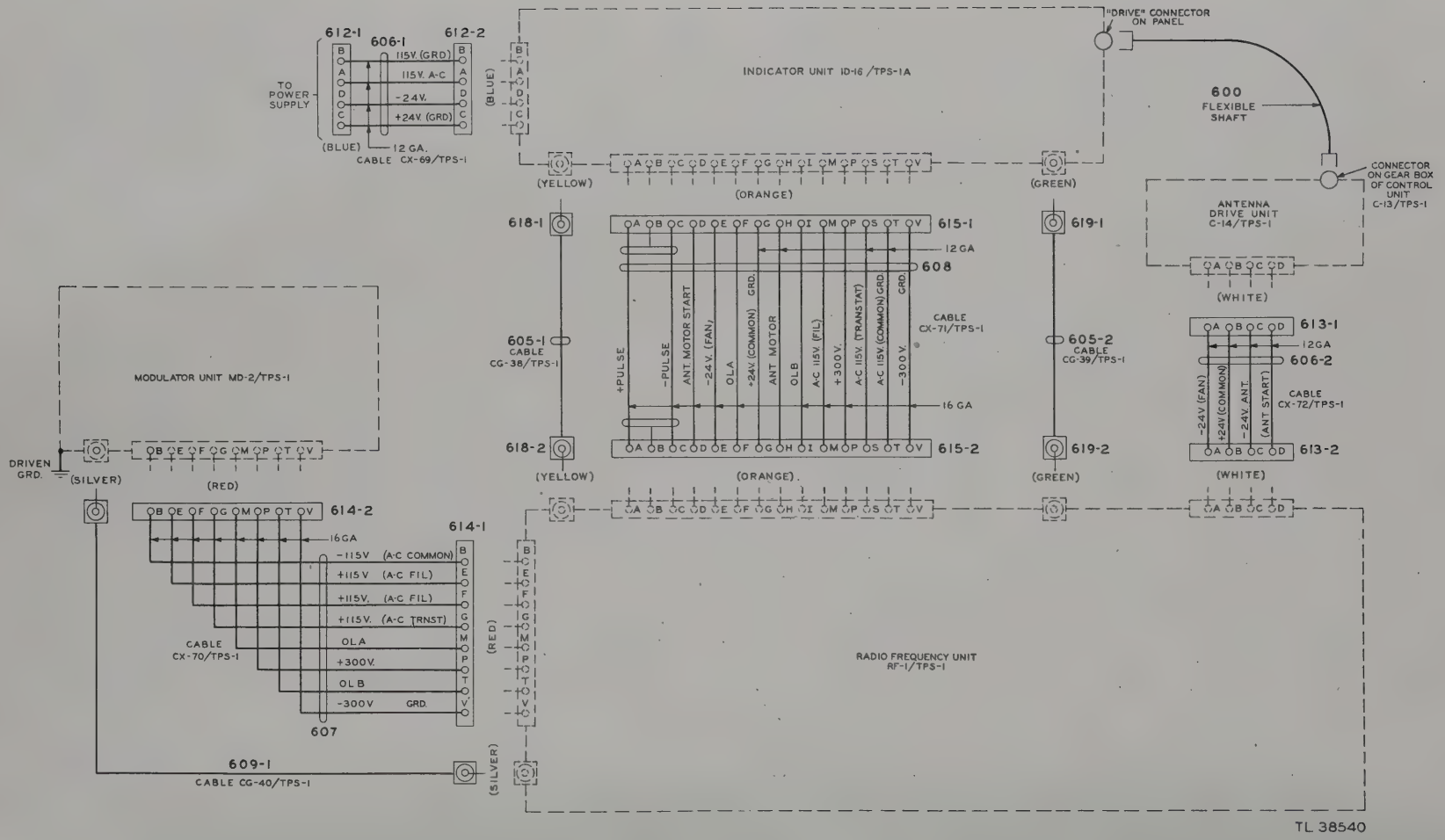

Figure 5. Radio Set AN/TPS-1A, cabling diagram.

for interconnecting the components of the equipment. Connectors and cables are marked or banded with color to identify them; this is called their color code. A cable end with a color band is inserted in the connector with the same color marking. Both ends of each cable are equipped with the same type of connectors, except for the silver cable, making them interchangeable end for end. A schematic diagram of interconnections is given in figure 5, and the cables are listed in table I on page 5.

3. BLOCK DIAGRAM OF RADIO SET AN/TPS-1A.

a. A block diagram of Radio Set AN/TPS-1A is shown in figure 6. The radio waves are produced by a magnetron oscillator, a vacuum tube placed in a powerful magnetic field. The magnetron oscillates at a frequency determined by its construction, but only when energized by a high-voltage pulse from the modulator. The modulator contains a multivibrator which determines the pulse-recurrence frequency. The modulator produces high-voltage pulses at a rate of 400 per second. These pulses are applied through a pulse transformer to the magnetron and cause it to oscillate for the brief period of each pulse. Although the periods of oscillation are short, considerable heat is generated because of the high power, and the magnetron must be cooled by a blower.

b. The high-frequency oscillations are picked up by a loop of wire in the magnetron and transmitted over coaxial conductors to the antenna where they are projected into space as radio waves.

c. The reflected waves are received by the same antenna and transmitted back to the receiving equipment over the same coaxial transmission line. The T-R box on this transmission line is a tuned cavity which acts as a valve to prevent more than a small amount of the outgoing energy from going into the receiver, and also to transmit the incoming reflected waves to the receiver. These reflected waves have very little energy because the power received varies inversely as the fourth power of the distance over which the waves have traveled. They are, therefore, immediately amplified in

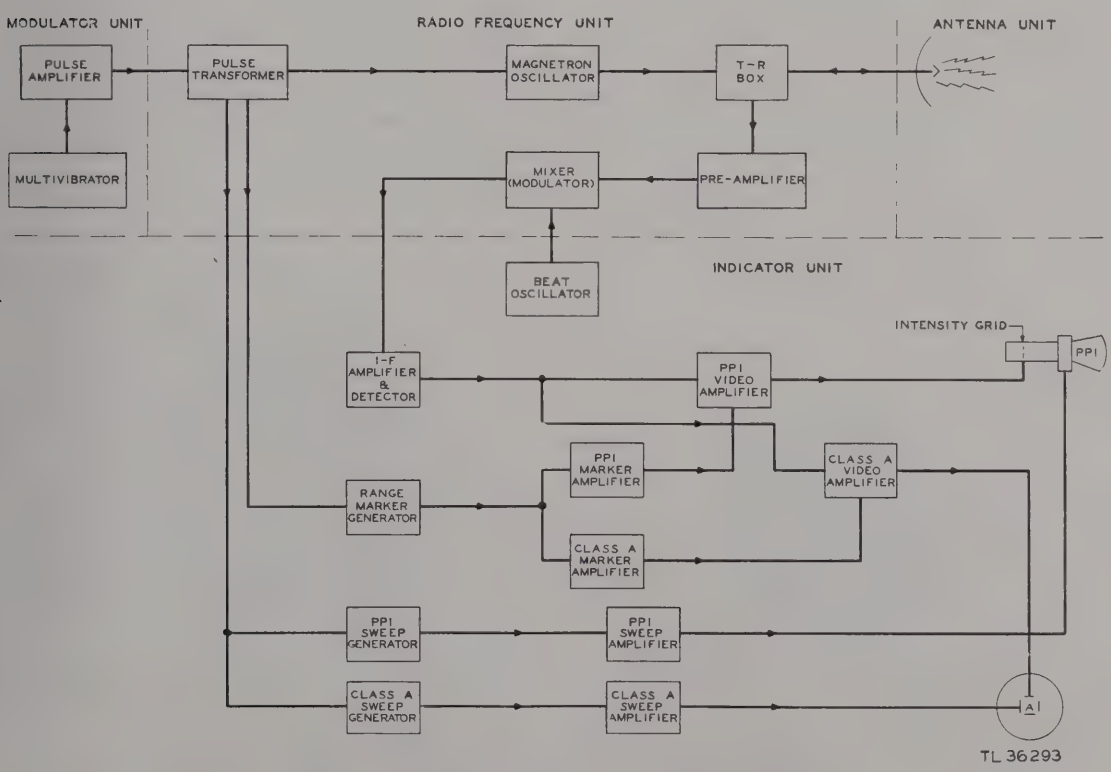

Figure 6. Radio Set AN/TPS-1A, block diagram.

the two preamplifiers of the radio-frequency unit. The preamplifiers are small vacuum tubes, the interelement networks of which are tuned cavities. Tuned cavities are used because ordinary capacitors for this high frequency would be very small and would be difficult to tune accurately.

d. The amplified energy of the reflected waves is then applied to the input of the mixer in the radio-frequency unit. This is a vacuum tube with tuned cavities similar to the preamplifiers, but with two inputs. To the other input is applied a second frequency just 60 megacycles below the frequency of the reflected waves (the same as the frequency of the magnetron). This second frequency is produced by the beat oscillator in the indicator unit which is also a vacuum tube with tuned cavities similar to the preamplifiers. The two frequencies produce a beat frequency, just as two musical notes will produce a beat. This is the 60-megacycle intermediate frequency. Summarizing, short pulses of high-frequency oscillations produced by the magnetron when energized by the modulator are projected into space as radio waves from the antenna. These waves, reflected back from any object in their path, are received by the antenna and carried back to the T-R box. They are amplified in the two preamplifiers and their presence is detected by the beat which they produce in the mixer with the frequency supplied by the beat oscillator.

e. In order to make a visual record of the received reflected waves, they are made to control the electron beams of two oscilloscopes in the indicator unit. The i-f output of the mixer is first amplified in four i-f stages in the i-f amplifier assembly of the indicator unit. A fifth tube in the i-f amplifier assembly is a detector which rectifies the amplified signal, resulting in a series of unidirectional pulses at the pulse rate of the modulator whenever reflected waves are being received. These pulses are amplified in the video amplifiers of the indicator unit and applied to the deflecting plates of the Class A oscilloscope and to the intensity grid of the PPI oscilloscope. Whenever reflected waves are received, therefore, the beam of the Class A oscilloscope is deflected and the beam of the PPI oscilloscope is brightened, indicating the presence of the object which reflected the waves.

f. In order to measure the time which the waves have taken to travel to the reflecting object and back, the beams of the oscilloscopes are made to sweep across the oscilloscope screens in synchronism with the pulse. A synchronizing voltage is supplied by the pulse transformer. On the Class A oscilloscope (fig. 7) the beam travels horizontally from left to right across the middle of the screen. On the PPI oscilloscope (fig. 8) the beam travels from the center to the edge. In each case the beam must return to its starting point in order to make another sweep, but during this time,

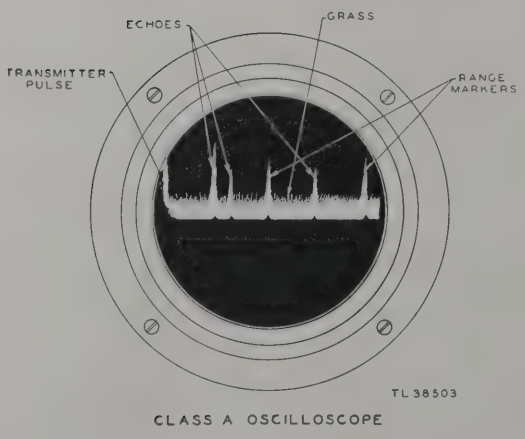

Figure 7. Class A oscilloscope display.

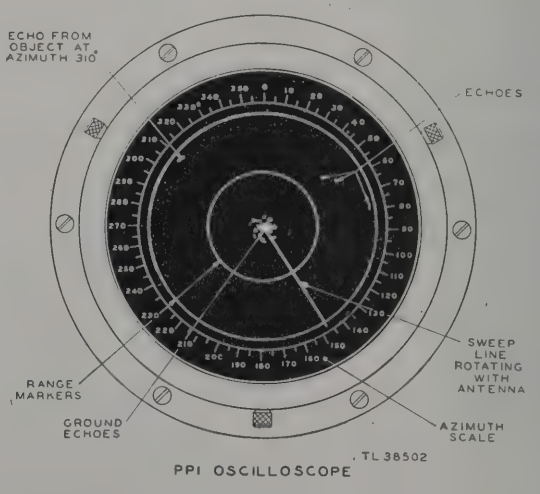

Figure 8. PPI oscilloscope display.

which is very short, it is blanked out and leaves no trace. The sweep on each oscilloscope is started by the modulator pulse so that it begins when the magnetron starts to oscillate and send out the radio waves. On the Class A oscilloscope the outgoing energy from the magnetron produces a deflection of the electron beam at the start of the sweep. The sweeps move across the screens of the oscilloscopes at a constant speed; therefore, the position of the electron beam at any instant corresponds to the distance which the radio waves have traveled. When reflected waves are received, the electron beam of the Class A oscilloscope is deflected into a peak or "pip" and the distance of this pip from the start of the sweep is a measure of the time which it has taken for the radio waves to go out from the radio set and return. It is also, therefore, a measure of the distance to the object which reflected them. Upon pressing the RANGE MARKER button on the indicator unit, range marker pips are produced at the positions on the sweep where reflected waves would be received from objects at 10-mile intervals away. The distance of the actual object which is reflecting the waves can then be estimated from these pips.

g. In the same way, when reflected waves are received, the electron beam of the PPI oscilloscope (fig. 8) is intensified, producing a bright spot. The distance of this spot from the start of the sweep at the center of the screen is a measure of the time taken for the waves to travel to the object and back and, therefore, a measure of the distance to the object. By pressing the RANGE MARKER button, bright spots are produced at the positions on the sweep where reflected waves would be received from objects 10 and 20 miles away (if on 20-mile range).

h. Since the antenna beam is narrow, reflections are received from an object only when the beam is directed at the object. The oscilloscopes show reflections only from the direction in which the antenna is pointed. If the antenna is rotated, the reflection from an object is indicated on the Class A oscilloscope only when the antenna beam passes across that object and not when it is pointed elsewhere. The PPI oscilloscope, however, is provided with rotating deflection coils driven from the antenna which cause the sweep line on that oscilloscope to rotate in synchronism with the antenna. Whenever the antenna beam passes across a reflecting object, the received reflected waves produce a bright spot which, because of the persistence of the oscilloscope screen, remains for some time after the sweep line has passed. The persistence of the screen also causes the range marker spots to draw circles on the screen as the deflection coils rotate. The PPI oscilloscope, when the antenna is rotating, thus shows a map of the space swept by the antenna beam, with the location of the radio set as the center of the screen. The distance of a spot from the center of the screen is a measure of the distance from the radio set of the object which produced the spot and the direction of the spot from the center of the screen indicates the direction of the object from the radio set.

4. MAJOR COMPONENTS.

The major components of the equipment are:

- **a.** Modulator Unit MD-2/TPS-1, contained in tower section No. 1.
- **b.** Radio-Frequency Unit RF-1/TPS-1, contained in tower section No. 4.
- **c.** Control Unit C-13/TPS-1, forming tower section No. 3.
- **d.** Indicator Unit ID-16/TPS-1A, contained in tower section No. 2.
- **e.** Antenna Drive Unit C-14/TPS-1, forming tower section No. 5.
- **f.** Antenna AS-8/TPS-1.
- **g.** Test Set TS-91/TPS-1.
- **h.** Power Unit PU-6/TPS-1.
- **i.** Tent S-3/TPS-1.

5. TECHNICAL CHARACTERISTICS.

The principal technical characteristics of Radio Set AN/TPS-1A are as follows:

a. Range—

Maximum	100 miles (approx).
Minimum	Not less than 0.25 mile.
Determination	By range markers on oscilloscopes.

b. Azimuth—

Mechanical	360 degrees.
Operational	360 degrees.
Accuracy	± 3 degrees.
Scanning	By continuous rotation of antenna by motor drive.
Determination	By azimuth scale on PPI oscilloscope.

c. Elevation	No data furnished.
d. Tracking	By hand control of antenna.
e. Type of presentation	7-inch PPI oscilloscope and 5-inch Class A oscilloscope.
f. IFF	Not furnished but provision made for connection.
g. Frequency	1,074-1,086 mc (1,050-1,110 mc by change of magnetron).
h. Peak power	100 kw to approximately 150 kw.
i. Average power	80w to approximately 120w.
j. Pulse repetition rate	400 per second.
k. Pulse width	2 microseconds (approx).
l. Transmitting oscillator	Magnetron.
m. Antenna	Wire mesh paraboloid 15 feet wide by 4 feet high.
n. Beam width—	
Horizontal	3 degrees (approx).
Vertical	13 degrees (minimum).
o. Type of power unit	Gasoline-driven generator.
p. Power requirements	1,100w at 115v 400 cycles, and 180w at 27v direct current.
q. Dimensions of site	20 feet square (approx).
r. Total height	17 feet.
s. Total weight with two power units	1518 pounds.
t. Number of packages	12.

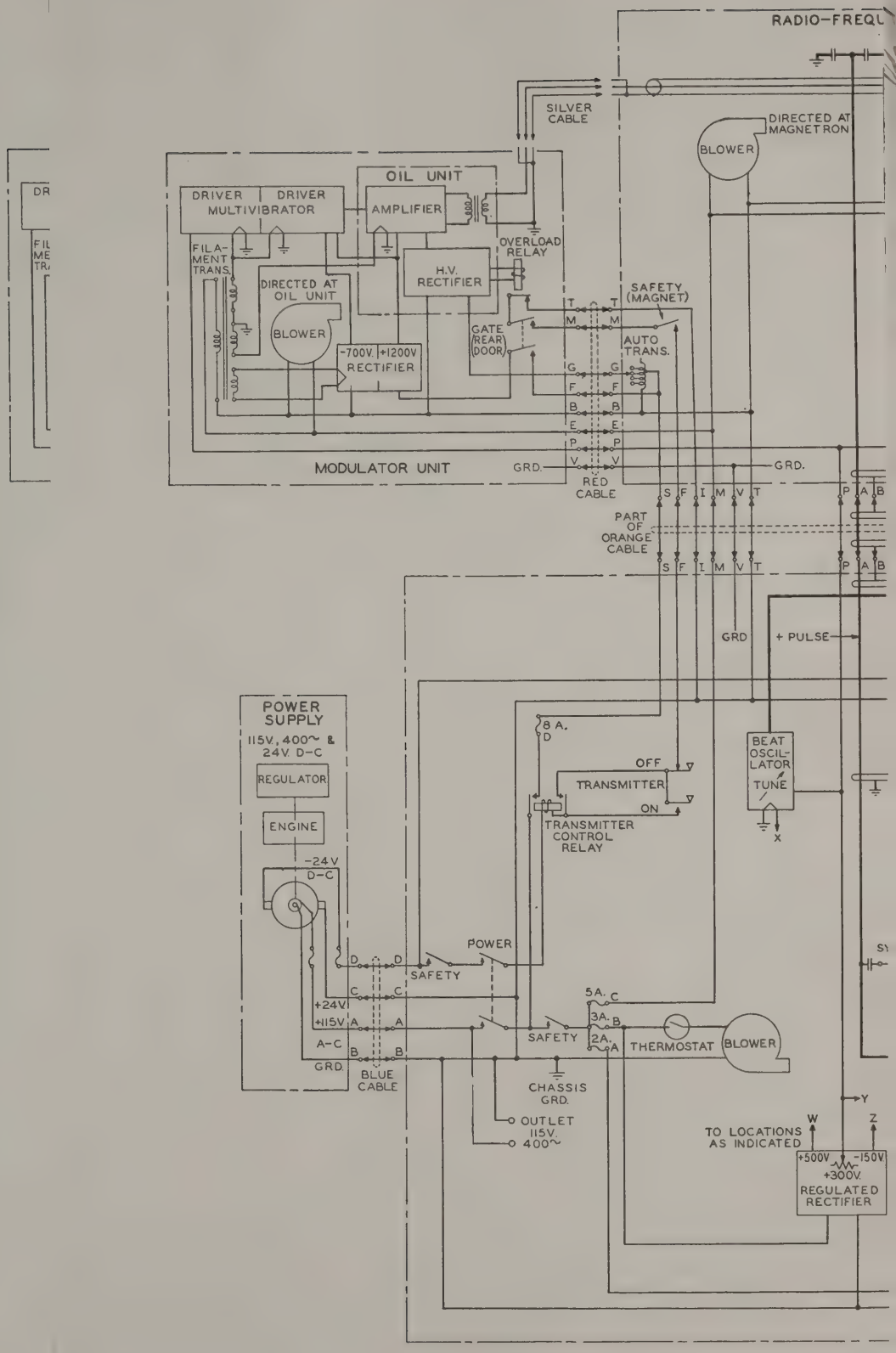

Figure 9. Radio Set AN/TPS-1A, block diagram and control system circuits.

c. Elevation	No data furnished.
d. Tracking	By hand control of antenna.
e. Type of presentation	7-inch PPI oscilloscope and 5-inch Class A oscilloscope.
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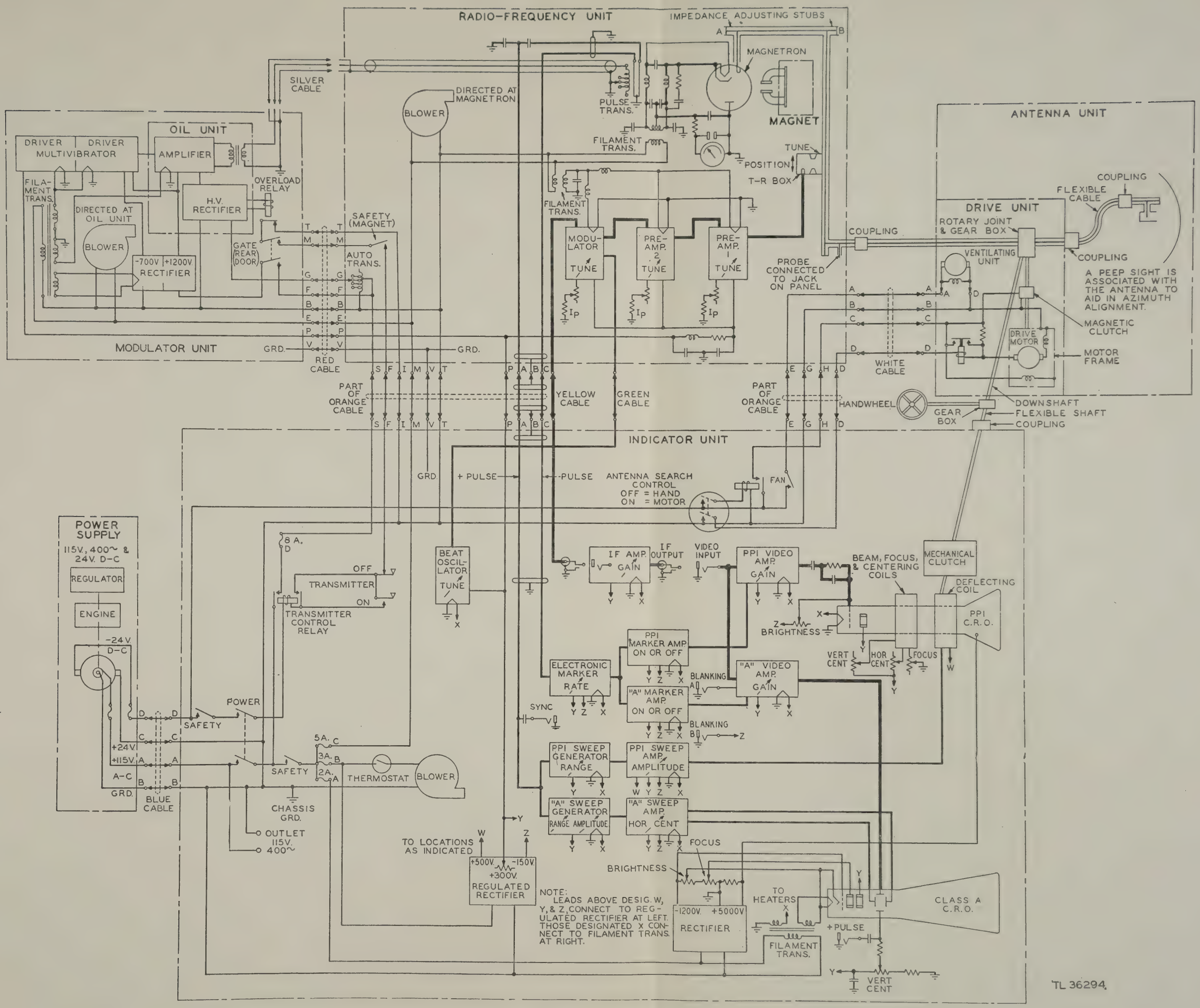
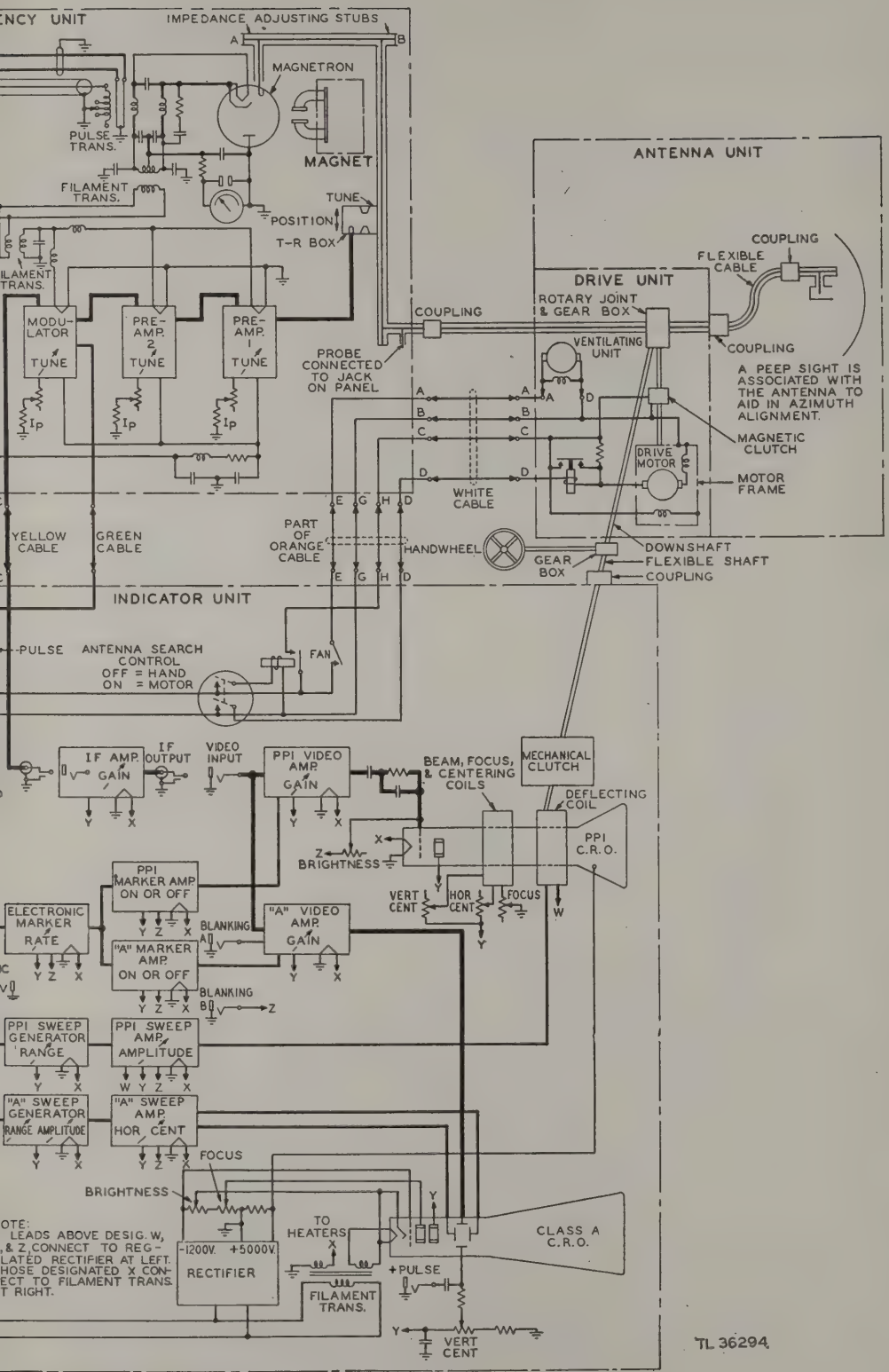


Figure 9. Radio Set AN/TPS-1A, block diagram and control system circuits.


ENCY UNIT
IMPEDANCE ADJUSTING STUBS
A
B
MAGNETRON
PULSE TRANS.
MAGNET
FILAMENT TRANS.
TUNE
POSITION
T-R BOX
ILAMENT TRANS.
MODU-LATOR TUNE
PRE-AMP. 2 TUNE
PRE-AMP. 1 TUNE
Ip
Ip
Ip
COUPLING
PROBE CONNECTED TO JACK ON PANEL
ANTENNA UNIT
DRIVE UNIT
ROTARY JOINT & GEAR BOX
COUPLING
FLEXIBLE CABLE
COUPLING
VENTILATING UNIT
A PEEP SIGHT IS ASSOCIATED WITH THE ANTENNA TO AID IN AZIMUTH ALIGNMENT.
MAGNETIC CLUTCH
DRIVE MOTOR
MOTOR FRAME
WHITE CABLE
YELLOW CABLE
GREEN CABLE
PART OF ORANGE CABLE
HANDWHEEL
GEAR BOX
DOWNSHAFT
FLEXIBLE SHAFT
COUPLING
INDICATOR UNIT
PULSE
ANTENNA SEARCH CONTROL
OFF = HAND
ON = MOTOR
FAN
IF AMP. GAIN
IF OUTPUT
VIDEO INPUT
PPI VIDEO AMP. GAIN
BEAM, FOCUS, & CENTERING COILS
MECHANICAL CLUTCH
DEFLECTING COIL
PPI C.R.O.
Z BRIGHTNESS
VERT CENT
HOR CENT
FOCUS
PPI MARKER AMP ON OR OFF
ELECTRONIC MARKER RATE
"A" MARKER AMP. ON OR OFF
BLANKING A
BLANKING B
"A" VIDEO AMP. GAIN
PPI SWEEP GENERATOR RANGE
PPI SWEEP AMP. AMPLITUDE
"A" SWEEP GENERATOR RANGE AMPLITUDE
"A" SWEEP AMP. HOR CENT
FOCUS
BRIGHTNESS
TO HEATERS
CLASS A C.R.O.
-1200V. +5000V.
RECTIFIER
+PULSE
FILAMENT TRANS.
VERT CENT
OTE:
LEADS ABOVE DESIG. W, & Z CONNECT TO REG-LATED RECTIFIER AT LEFT. HOSE DESIGNATED X CON-ECT TO FILAMENT TRANS. T RIGHT.
TL 36294

SECTION II
CONTROL SYSTEM

6. INTRODUCTION.

The control system (figs. 9 and 10) comprises the main power inputs, power and gate switches, starting and overload relays, and the means for driving and controlling the antenna.

7. POWER CIRCUITS.

The power input circuits and switches are shown schematically in figure 10. Power at 115 volts, 400 cycles and 27 volts direct current is supplied from the power unit over the blue cable to the GENERATOR receptacle on the indicator unit. The 27-volt supply to the indicator, r-f, and modulator units is opened by gate switch 342-2 if the indicator is withdrawn from its case; the 27-volt supply to the ventilating fan and antenna driving motor is independent of this switch. Both power supplies are

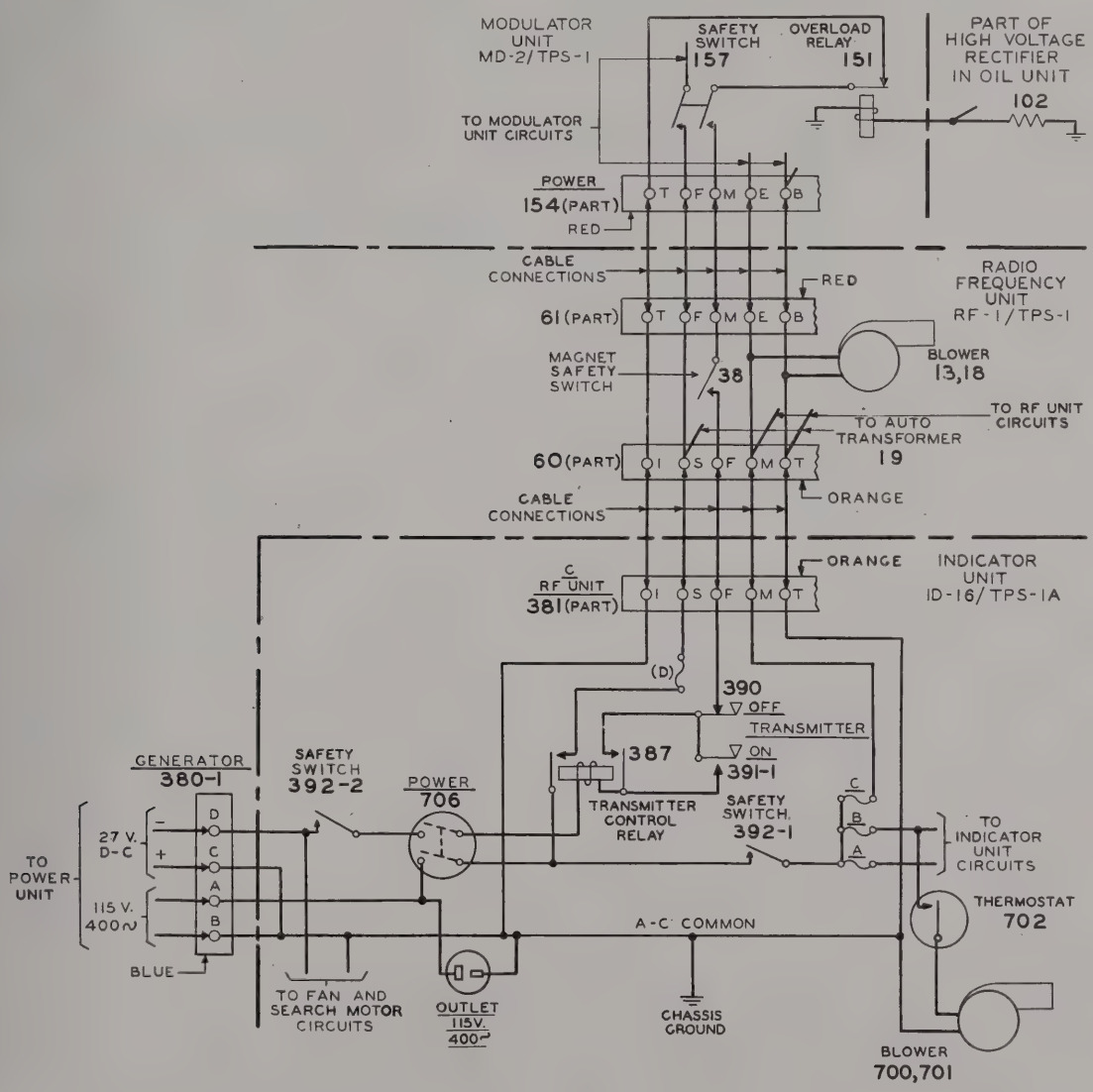


Figure 10. Control system, simplified schematic diagram.

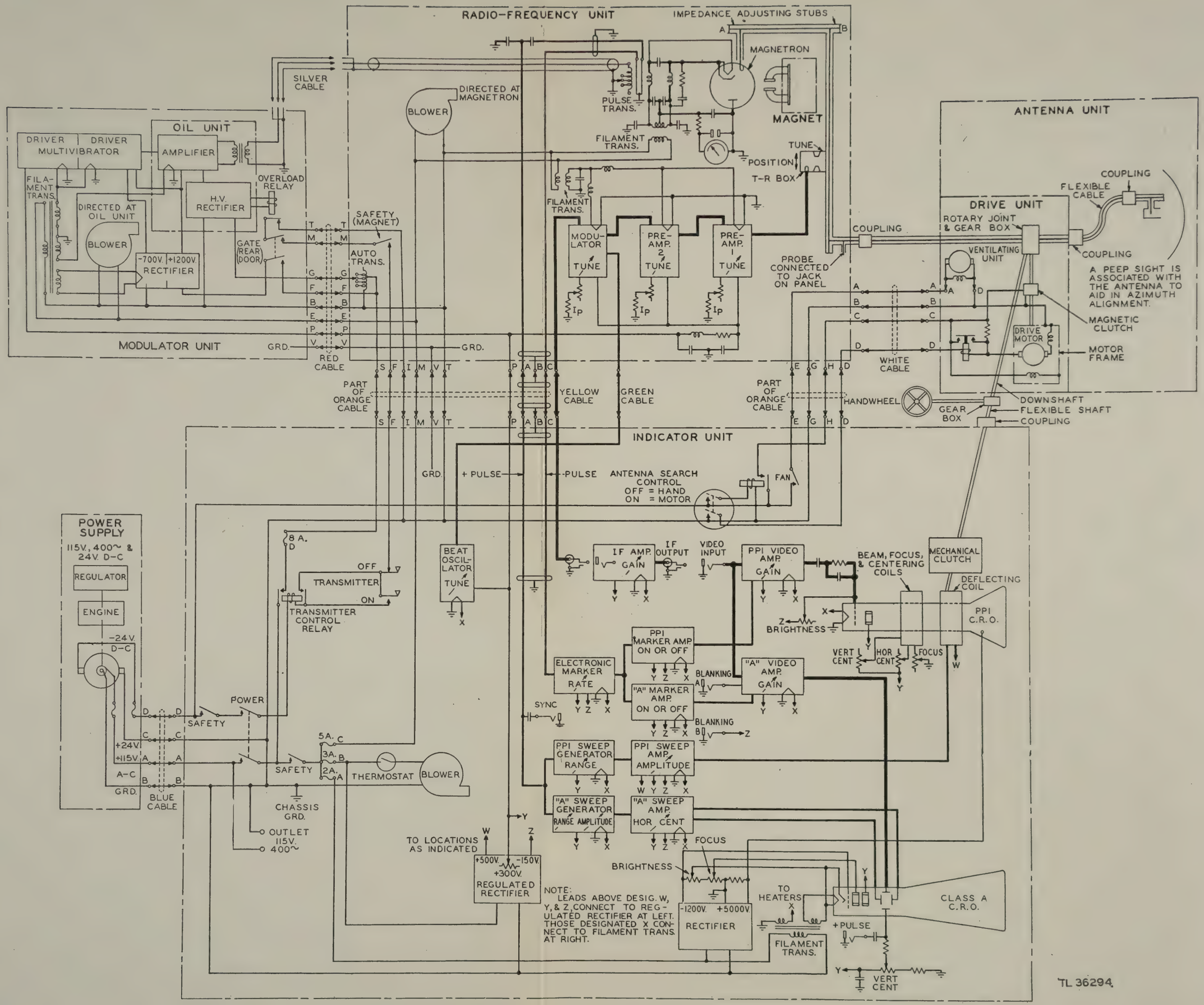


Figure 9. Radio Set AN/TPS-1A, block diagram and control system circuits.

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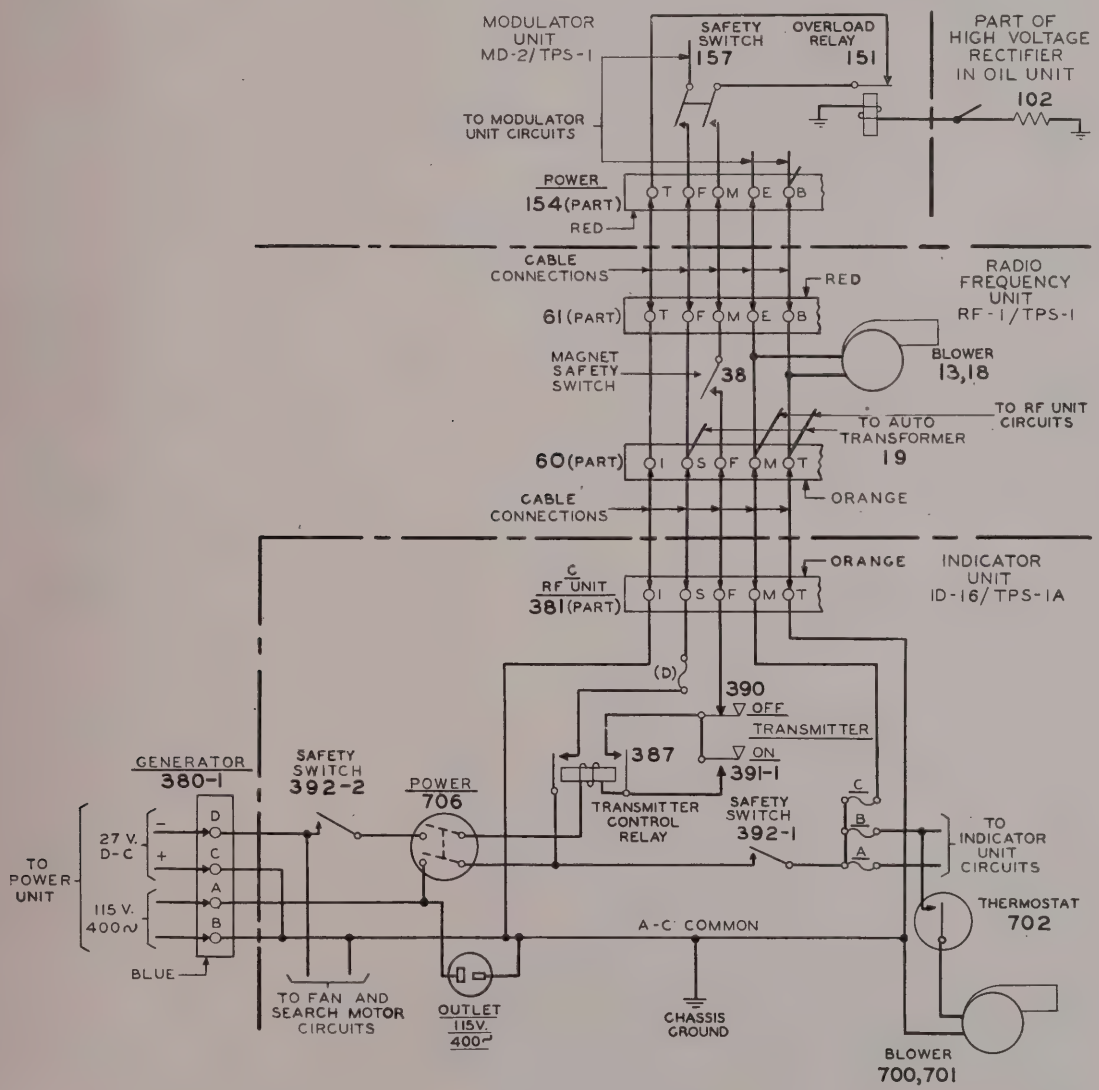


Figure 10. Control system, simplified schematic diagram.

controlled by POWER switch 339 on the indicator unit. Closing of the POWER switch supplies 115 volts alternating current to the indicator unit through fuses A and B, and to the r-f and modulator units through fuse C and the orange and red cables. These supplies are opened by gate switch 342-1 if the indicator unit is withdrawn from its case. Power is not supplied to the high-voltage rectifier of the modulator to produce pulses and operate the magnetron until TRANSMITTER ON button 337-2 in the indicator unit is pressed. Starting relay 365 then operates through the contacts of the TRANSMITTER OFF button, magnet gate switch 157 in the modulator unit, and the contacts of overload relay 151. This supplies 115 volts through fuse D to the rectifiers of the modulator unit and energizes the transmitter system. If the magnet is not raised high enough to close gate switch 38, if the door in the modulator unit giving access to the tubes of the air unit is opened, opening gate switch 157, or if overload relay 151 operates because the high-voltage rectifier of the modulator unit is drawing too much current, this circuit will be opened, relay 365 released, and power removed from the rectifiers of the modulator unit. Relay 365 locks up through its own contacts and the contacts of the TRANSMITTER OFF button. When this button is pressed, the circuit is broken and relay 365 released, removing power from the rectifier of the modulator unit.

8. ANTENNA CONTROLS.

a. Control Circuits. The circuits of the ventilating fan and antenna drive motor are shown in figures 11 and 9. The ventilating fan is controlled by FAN switch 388 on the indicator unit. When SEARCH switch 389 is at HAND, no power is supplied to the antenna drive motor. When this switch is thrown to MOTOR, relay 386 (in the indicator unit) is operated, applying power to antenna drive motor 500 and magnetic clutch 502. The armature of antenna drive motor 500 is in series with starting resistor 507. When the motor comes up to speed, relay 506 operates and short-circuits the starting resistor.

b. Antenna Drive Mechanical Parts (figs. 12 and 13). The antenna is revolved by the drive motor through a V-belt and a train of gears

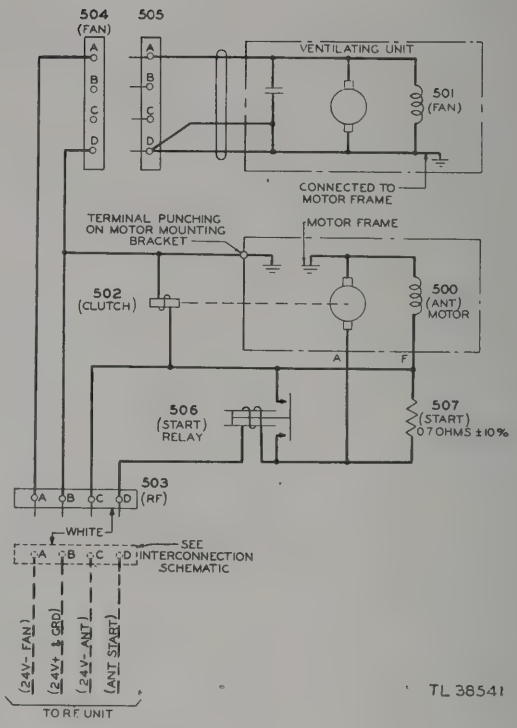


Figure 11. Antenna Drive Unit C-14/TPS-1, schematic diagram.

enclosed in a gearbox in the antenna drive unit (fig. 14). When the gearbox is in operating position, a pinion at the bottom of the gearbox engages a large gear on the spindle on which the antenna is mounted. The ratio of the gear train and belt drive is such that the antenna revolves at about 12 rpm at normal motor speed. For turning the antenna, a long shaft is connected between a squared shaft at the bottom of the gearbox and a similar shaft on a small bevel gearbox with handwheel mounted on tower section No. 3 (fig. 15). The gear ratios are such that ten turns of the handwheel are required for one revolution of the antenna. From the bottom of the gearbox a flexible shaft connects to the gearing which rotates the deflection coils of the PPI oscilloscope in the indicator unit so that the deflection coils rotate in synchronism with the antenna. By rotating the deflection coils independently of the antenna, the AZIMUTH knob on the indicator unit permits orienting the oscilloscope sweep.

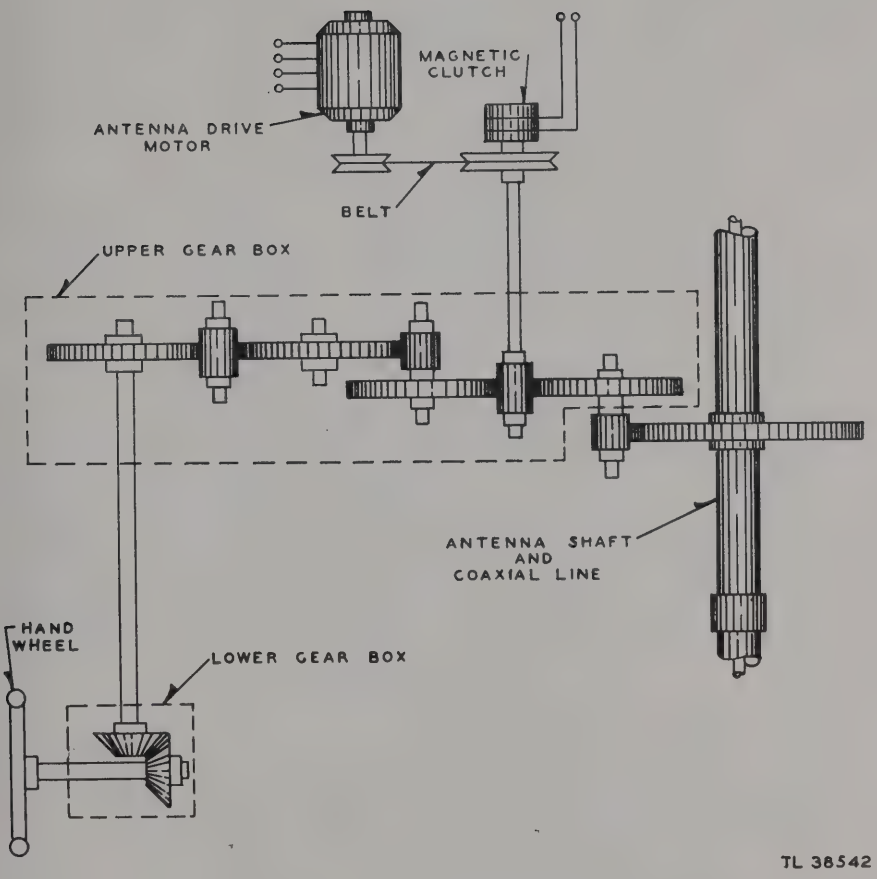


Figure 12. Mechanical antenna controls, schematic diagram.

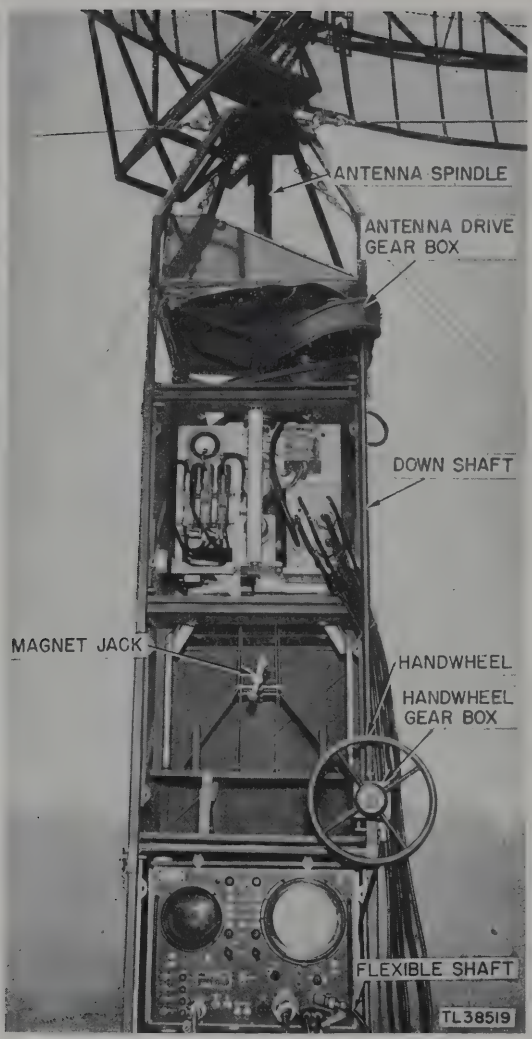


Figure 13. Location of control system parts.

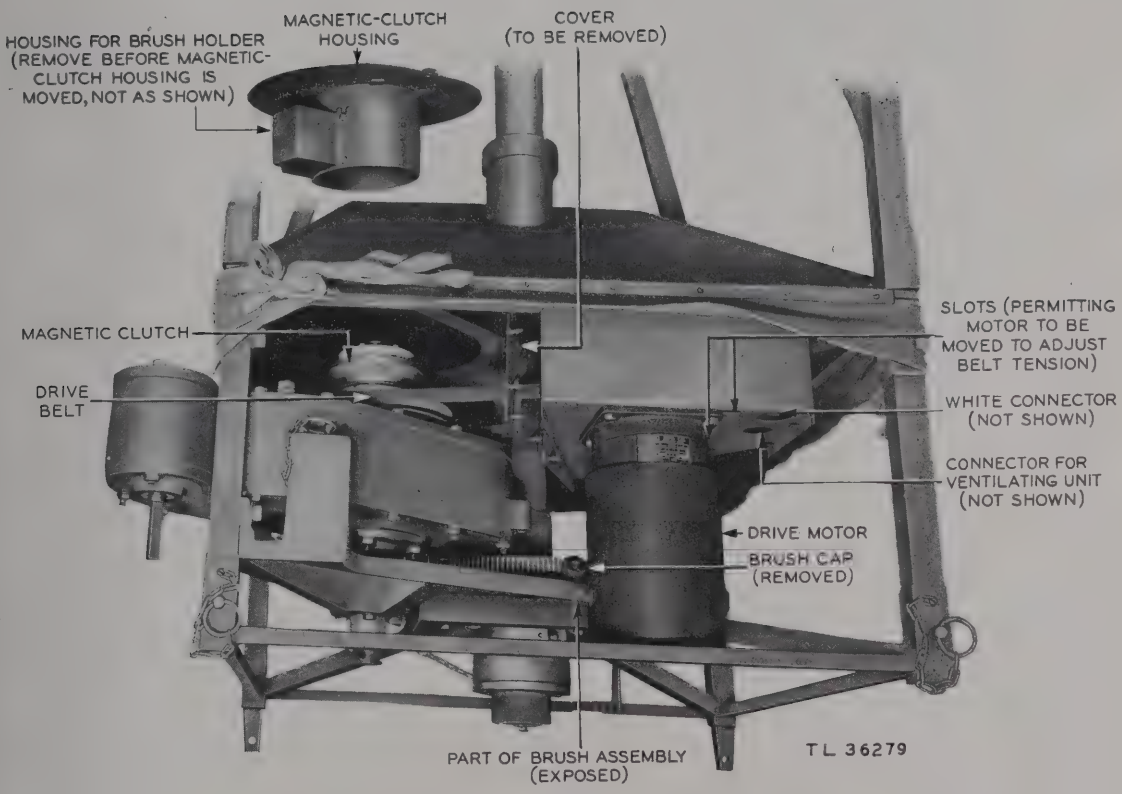

HOUSING FOR BRUSH HOLDER (REMOVE BEFORE MAGNETIC-CLUTCH HOUSING IS MOVED, NOT AS SHOWN)
MAGNETIC-CLUTCH HOUSING
COVER (TO BE REMOVED)
MAGNETIC CLUTCH
DRIVE BELT
SLOTS (PERMITTING MOTOR TO BE MOVED TO ADJUST BELT TENSION)
WHITE CONNECTOR (NOT SHOWN)
CONNECTOR FOR VENTILATING UNIT (NOT SHOWN)
DRIVE MOTOR
BRUSH CAP (REMOVED)
PART OF BRUSH ASSEMBLY (EXPOSED)
TL 36279

Figure 14. Antenna Drive Unit C-14/TPS-1, partially disassembled, right side view.

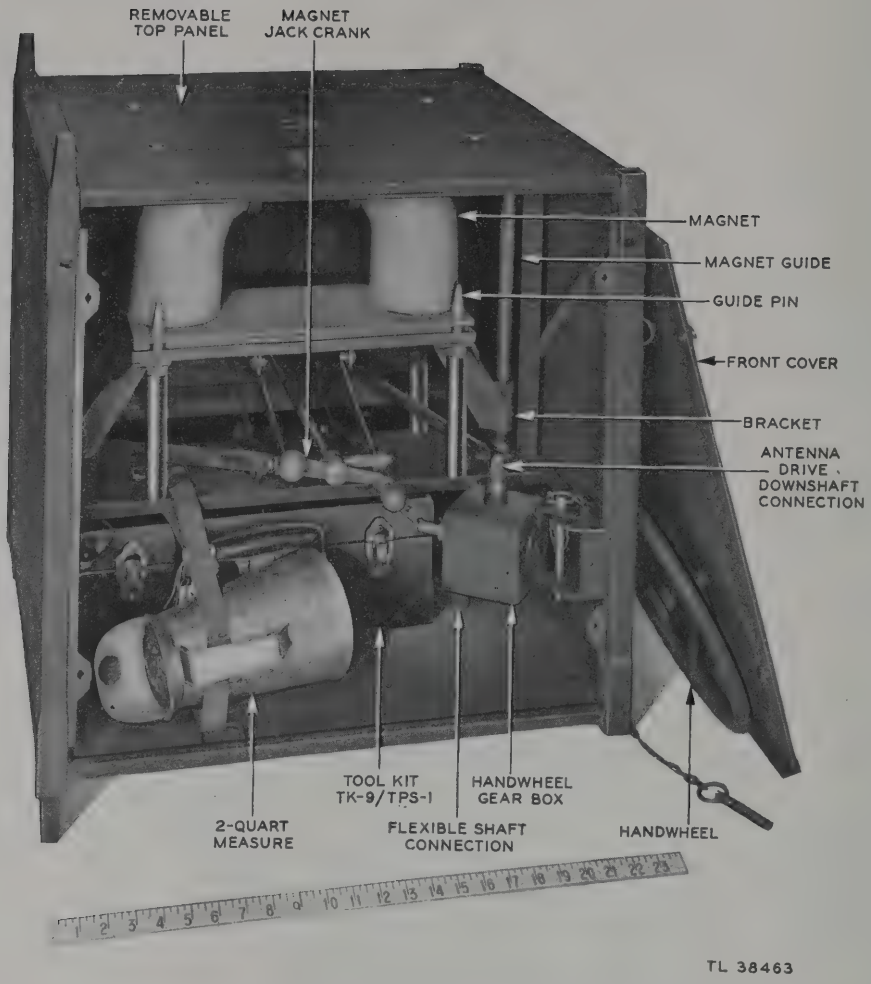


Figure 15. Tower section No. 3, showing Control Unit C-13/TPS-1 with magnet not raised.

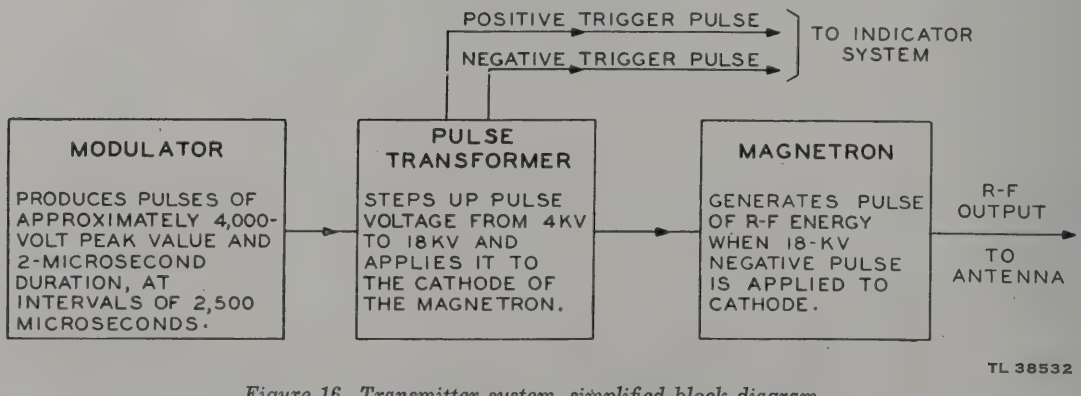

POSITIVE TRIGGER PULSE
NEGATIVE TRIGGER PULSE
TO INDICATOR SYSTEM
MODULATOR
PRODUCES PULSES OF APPROXIMATELY 4,000-VOLT PEAK VALUE AND 2-MICROSECOND DURATION, AT INTERVALS OF 2,500 MICROSECONDS.
PULSE TRANSFORMER
STEPS UP PULSE VOLTAGE FROM 4KV TO 18KV AND APPLIES IT TO THE CATHODE OF THE MAGNETRON.
MAGNETRON
GENERATES PULSE OF R-F ENERGY WHEN 18-KV NEGATIVE PULSE IS APPLIED TO CATHODE.
R-F OUTPUT
TO ANTENNA
TL 38532

Figure 16. Transmitter system, simplified block diagram.

SECTION III
TRANSMITTER SYSTEM

9. INTRODUCTION.

The transmitter system comprises a vacuum tube modulator providing the pulses for energizing the transmitting oscillator, a pulse transformer, and the transmitting oscillator (magnetron). A simplified block diagram describing the functioning of the system is shown in figure 16, and a complete block diagram is given in figure 17.

10. MODULATOR.

The modulator (figs. 18 and 19) contains a free-running multivibrator, a pulse-forming network, a pulse amplifier, and three vacuum tube rectifiers providing suitable voltages. The pulse amplifier and high-voltage rectifier tubes are contained in an oil-filled compartment (fig. 20). A blower directs a blast of air against the outside of this compartment to cool it. Transformer 108 through which the high-voltage pulses are transmitted is contained in another compartment (fig. 21) which is filled with oil by a vacuum process during manufacture.

a. Multivibrator Circuit. The multivibrator and associated rectifier circuits are located in the tube compartment of the modulator air unit (fig. 23). A simplified schematic of the multivibrator circuit is shown in figure 24. Tube 160 operates with a positive grid bias supplied by external 300-volt supply through resistor 133-4. Grid bias for tube 161 is furnished by the 675-volt rectifier in this unit through FREQ ADJ potentiometer 137. Assuming that both tubes are conducting (tube 161 having just started to conduct), any increase of plate current in tube 161 increases the voltage drop across resistor 129, applying a positive voltage through capacitor 143 to cathode resistor 123 of tube 160. The resulting increase of grid-cathode potential decreases the current through tube 160. The resulting decrease of voltage drop across resistors 138-1 and 138-2 applies a positive voltage through capacitor 144 to the grid of tube 161, further increasing the current through this tube. Thus, a small increase of current through tube 161 causes a further rapid increase which continues until capacitor 144 is fully charged. The leak to ground provided by resistors 128, 137, 136, and 139-2 is high resistance so the charge is held on capacitor 144 for some time. As the grid of tube 161 accumulates a negative potential, the current through resistor 129 ceases to increase and the extra bias on the cathode of tube 160 is removed. The timing of this removal is about 5 microseconds and is determined by the time constant of resistors 123 and 129 and capacitor 143. The current through tube 160 then increases, applying additional negative bias to the grid of tube 161 through capacitor 144 until tube 161 is biased beyond cut-off and ceases to conduct. The charge on capacitor 144 then leaks off through resistors 128, 137, 136, and 139-2, and the negative bias on the grid of tube 161 is removed allowing tube 161 to start conducting again. This starts the cycle over again. The time required for the charge on capacitor 144 to leak off sufficiently for tube 161 to become conducting is about 2,500 microseconds so that the cycle is repeated about 400 times per second. The exact rate is adjustable by changing the grid bias of tube 161 by means of potentiometer 137.

b. Pulse-shaping Network and Pulse Amplifier. The pulse wave produced by tube 161 lasts for about 6 to 8 microseconds and is not steep-fronted because the current through pulse-shaping network 115 builds up slowly. However, it terminates suddenly when tube 161 cuts off. At this sudden termination, a square pulse of about 2 microseconds duration is produced by the effect of the pulse-shaping network which is similar to that of a short-circuited line. This pulse is amplified in tubes 105-1 and 105-2 in parallel. The grids of these tubes are biased at —675 volts from the rectifier in this unit through resistor 130. This limits the amount which they can be driven positive since, when the grids draw current, the drop in resistor 130 limits the positive bias of the grids. This limits the plate current and makes the pulse square-topped. The magnitude of the pulse is controllable by adjusting the plate voltage of tubes 105-1 and 105-2 by changing taps on a tapped autotransformer in the power

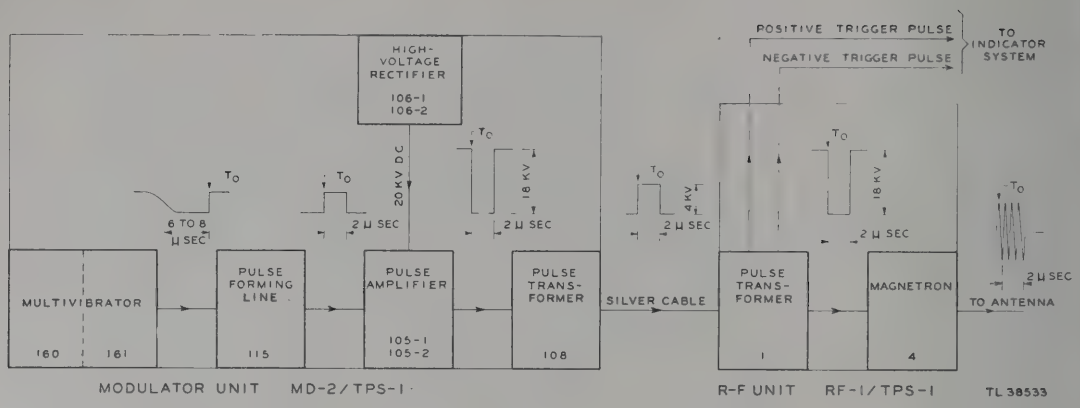


Figure 17. Transmitter system, complete block diagram.

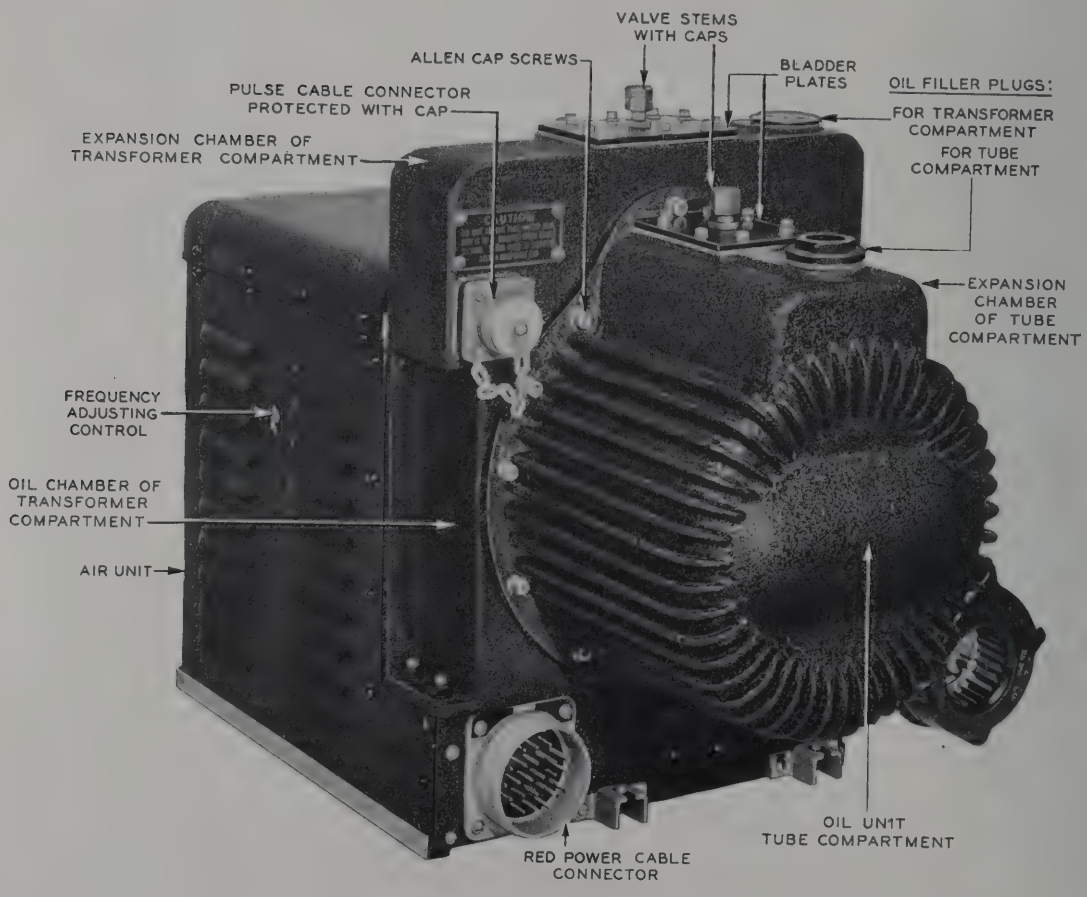


Figure 18. Modulator Unit MD-2/TPS-1, front oblique view.

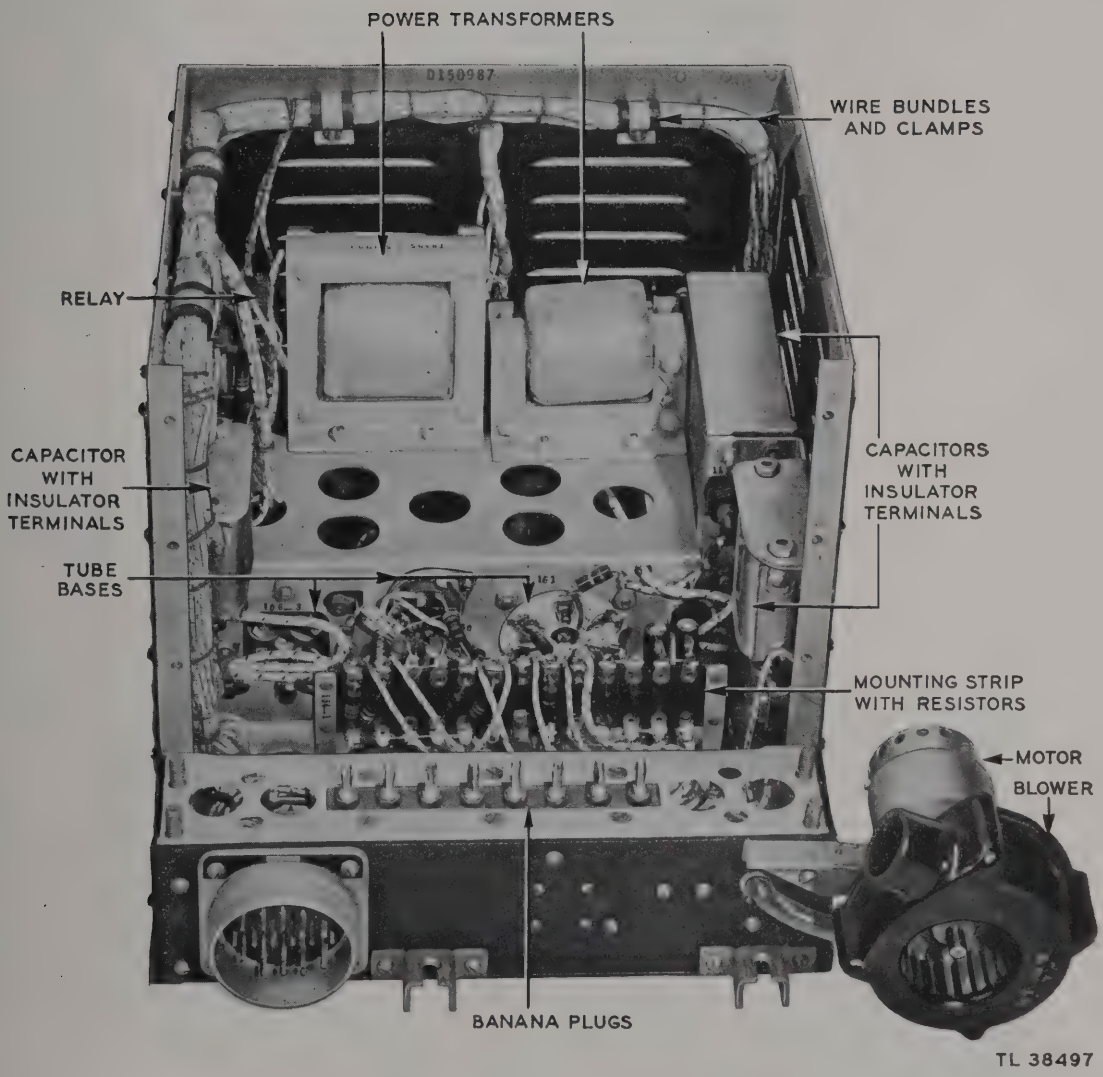


Figure 19. Modulator Unit MD-2/TPS-1, oil unit removed to show air unit.

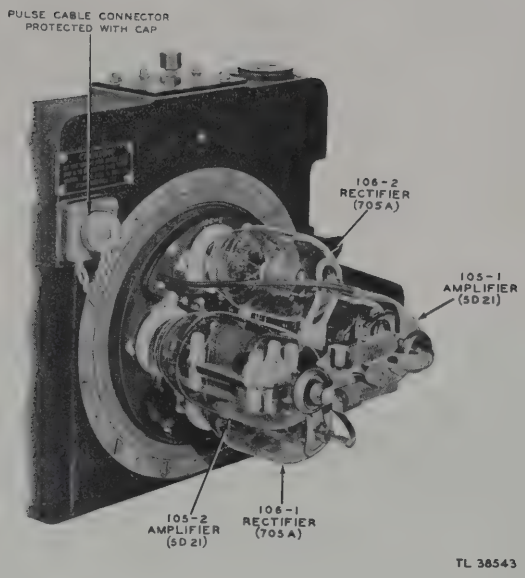


Figure 20. Modulator Unit MD-2/TPS-1, cover removed to show vacuum tube compartment of oil unit.

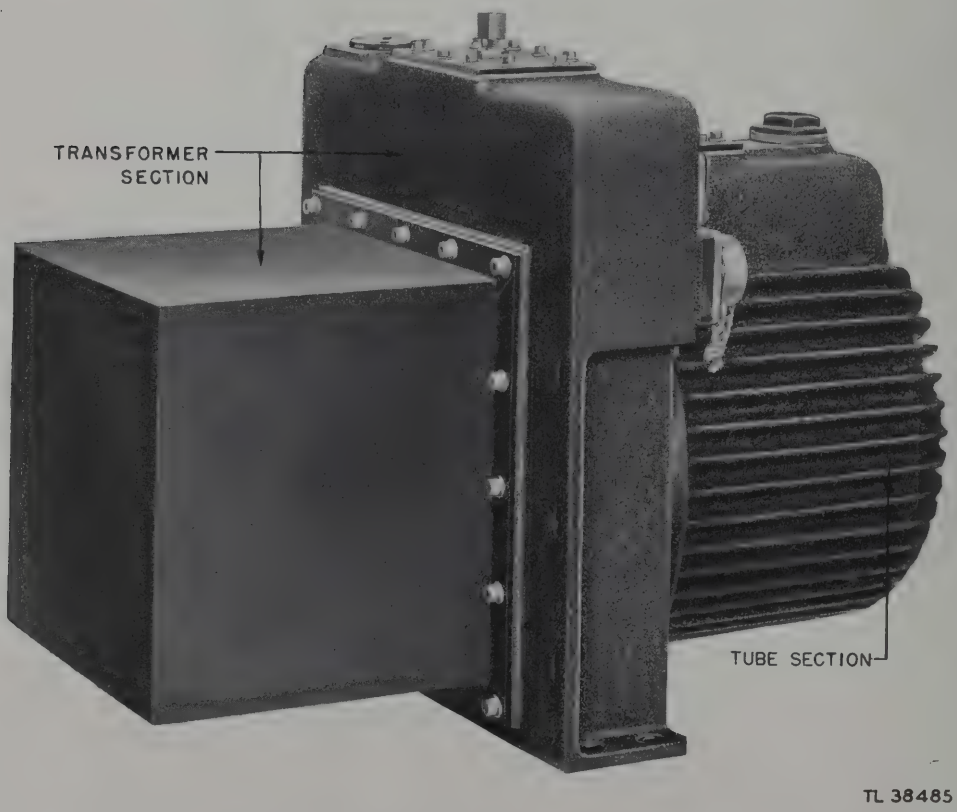
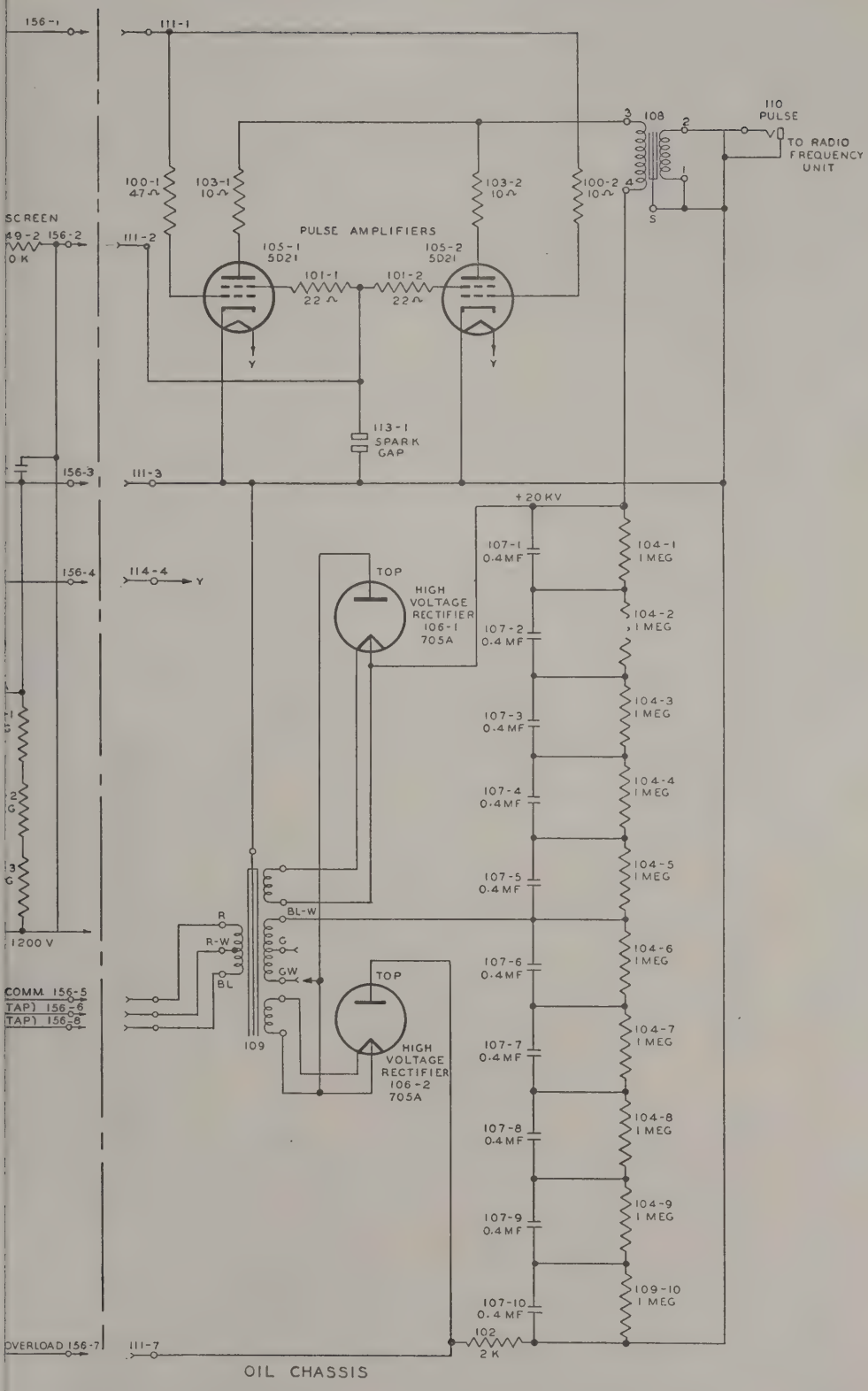


Figure 21. Modulator Unit MD-2/TPS-1, oil unit.



TL 38548

Figure 22. Modulator Unit MD-2/TPS-1, complete schematic diagram.

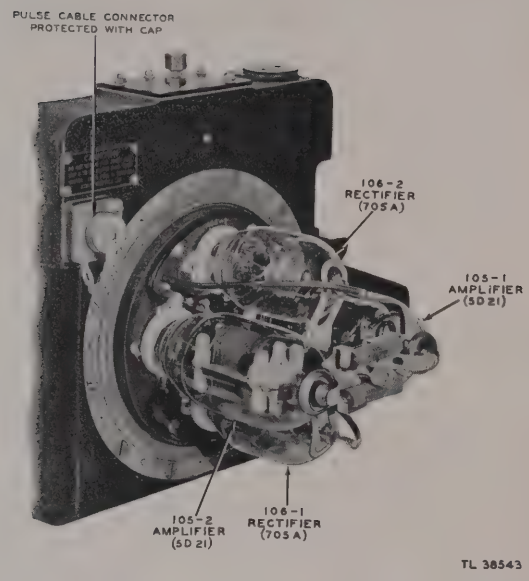


Figure 20. Modulator Unit MD-2/TPS-1, cover removed to show vacuum tube compartment of oil unit.

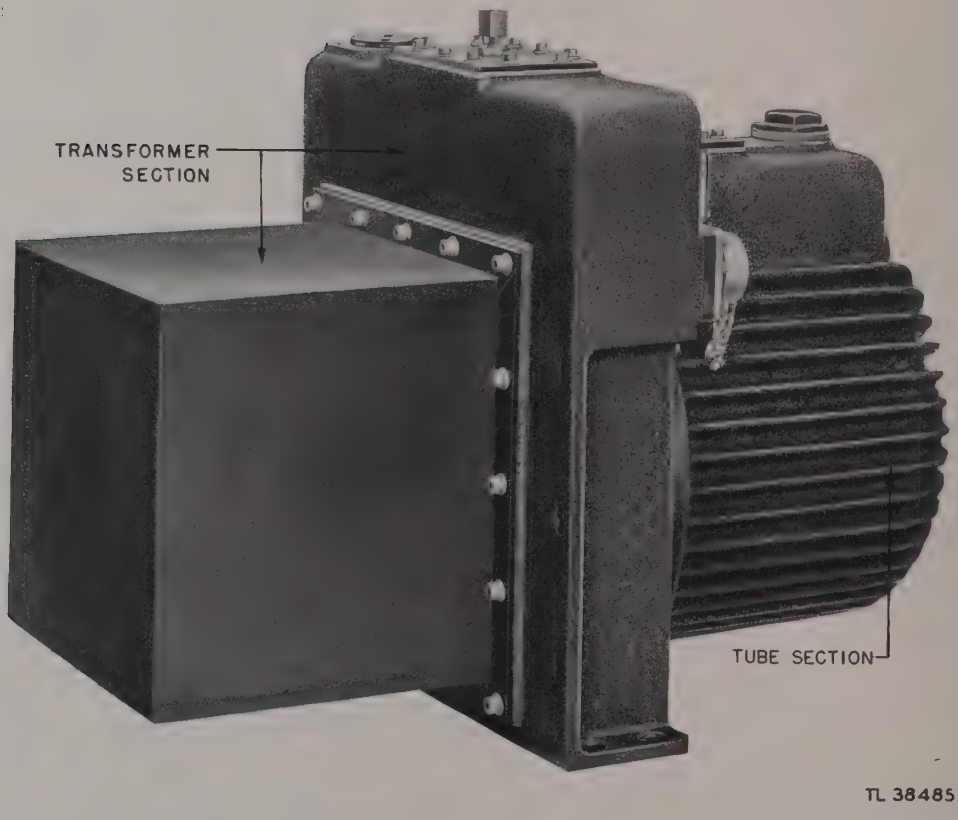


Figure 21. Modulator Unit MD-2/TPS-1, oil unit.

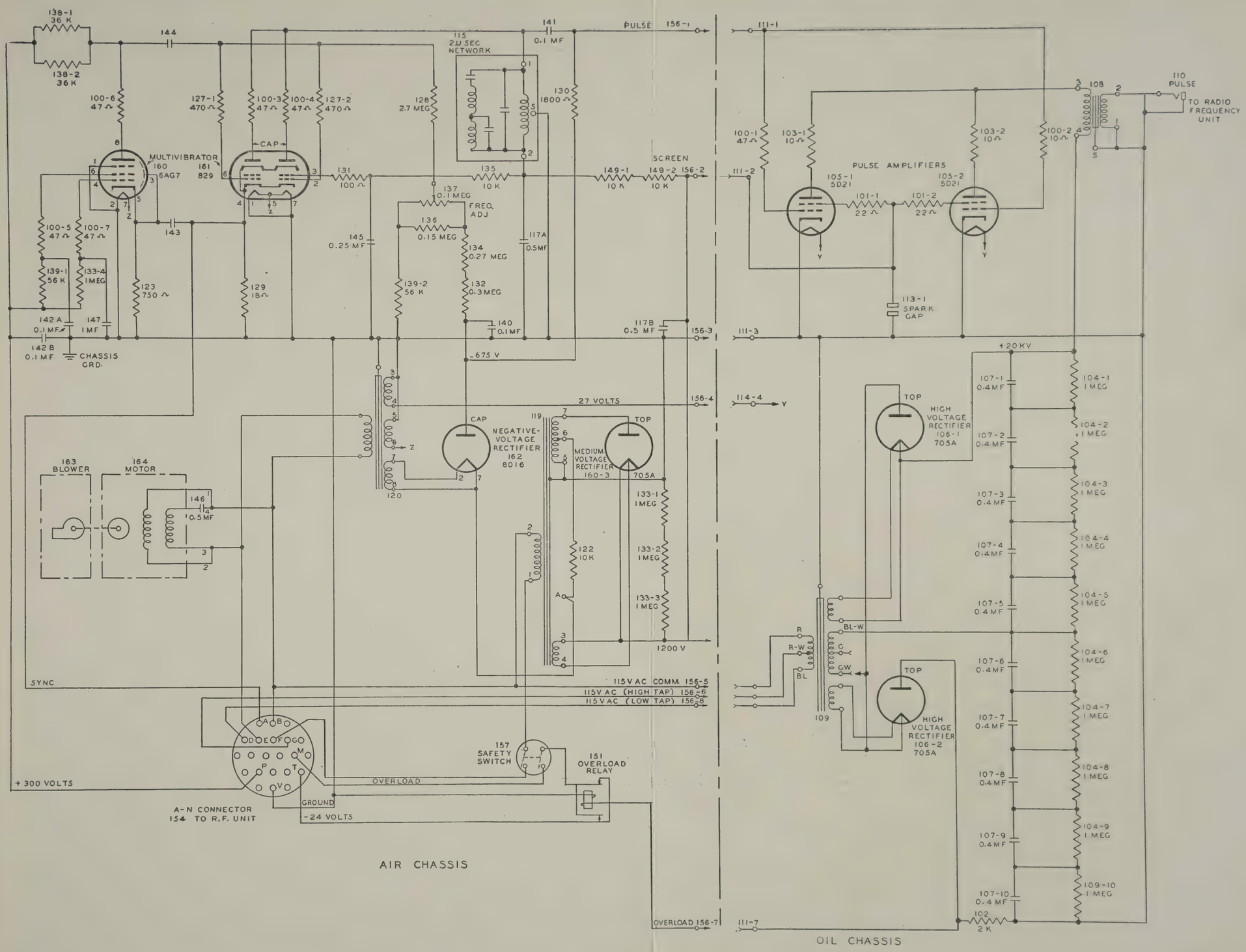


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Figure 22. Modulator Unit MD-2/TPS-1, complete schematic diagram.

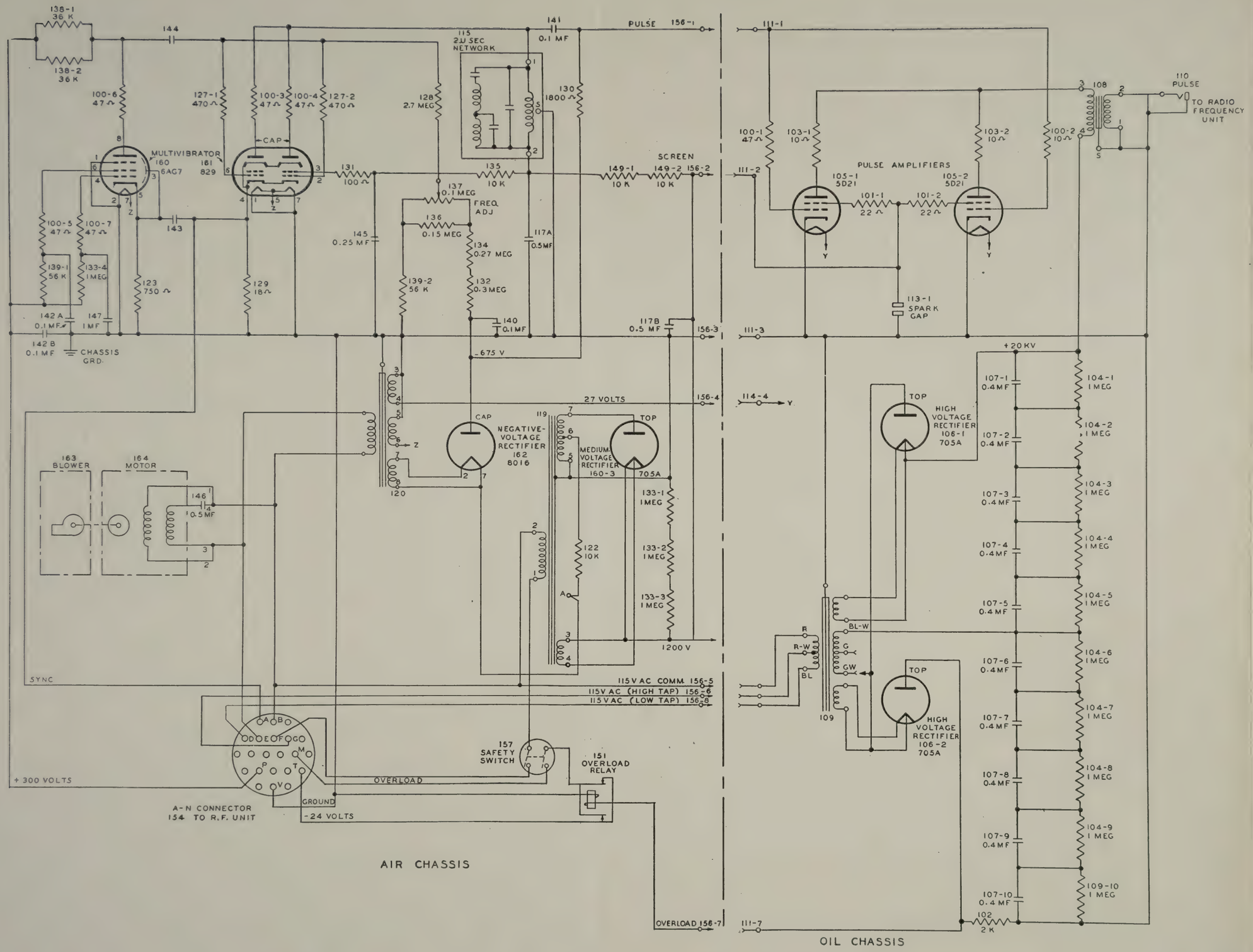

Figure 22. Modulator Unit MD-2/TPS-1, complete schematic diagram.

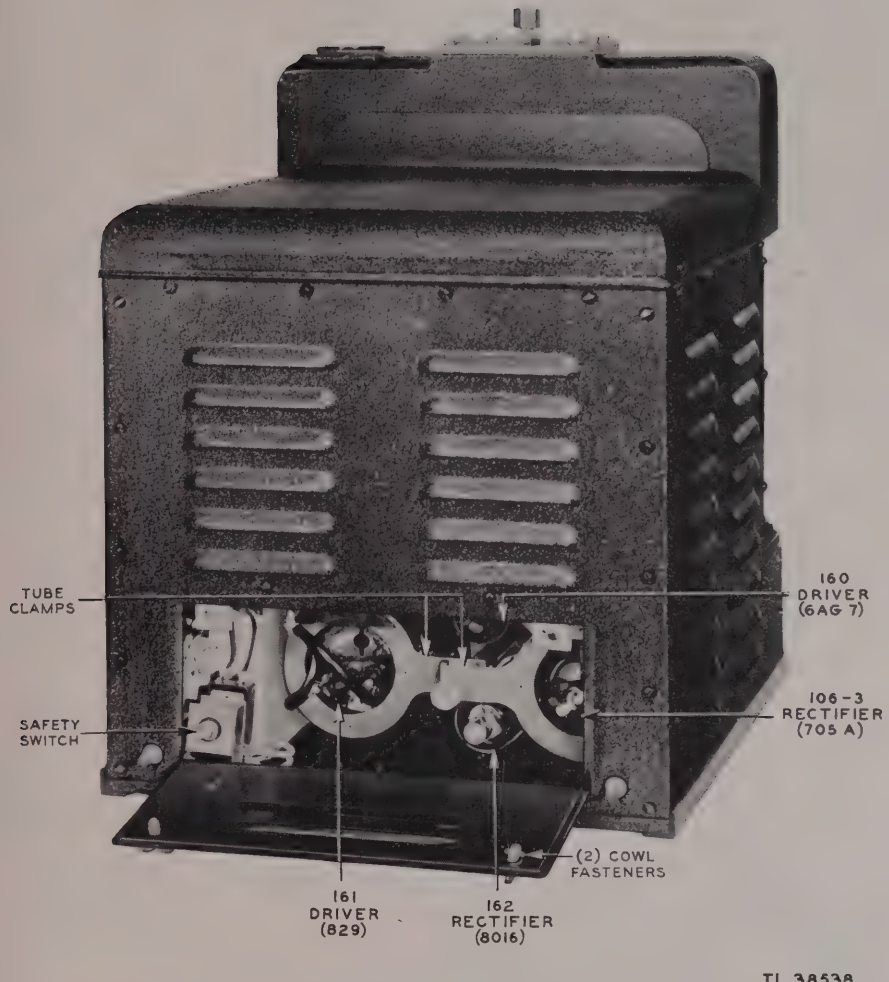

Figure 23. Modulator Unit MD-2/TPS-1, rear view showing vacuum tube compartment.

supply circuit to the high-voltage rectifier in this unit. The transformer is located in the radio-frequency unit. Transformer 108 reduces the peak voltage of the pulse from about 18 kilovolts to about 4 kilovolts for transmission through a cable to the radio-frequency unit. Resistors 100-1 to 100-7, 101-1, 101-2, 103-1, 103-2, 127-1, 127-2, and 131 (fig. 22) are anti-singing resistors to prevent the circuits oscillating at unwanted frequencies.

c. Rectifiers. Single-wave rectifier tubes 162 and 106-3 (fig. 22) produce —675 volts and +1,200 volts, respectively, for operation of the multivibrator and pulse amplifier tubes. To produce the high voltage required for the pulse, a voltage doubler rectifier composed of tubes 106-1 and 106-2 is employed. Transformer 109 produces high voltage at 10 kilovolts for rectification and heater voltages for the tubes. Tube 106-1 rectifies the positive half of the alternating wave to +10 kilovolts direct current and tube 106-2, the negative half, to —10 kilovolts direct current. The output of tube 106-2 is grounded so that the output of tube 106-1 is is 20 kilovolts above ground. The high voltages require high insulation in the transformer which is immersed in oil in a separate compartment.

d. Protective Features. (1) Overload relay 151 (shunted by resistor 102) will be operated if the average current drawn from the high-voltage rectifier exceeds about 55 milliamperes.

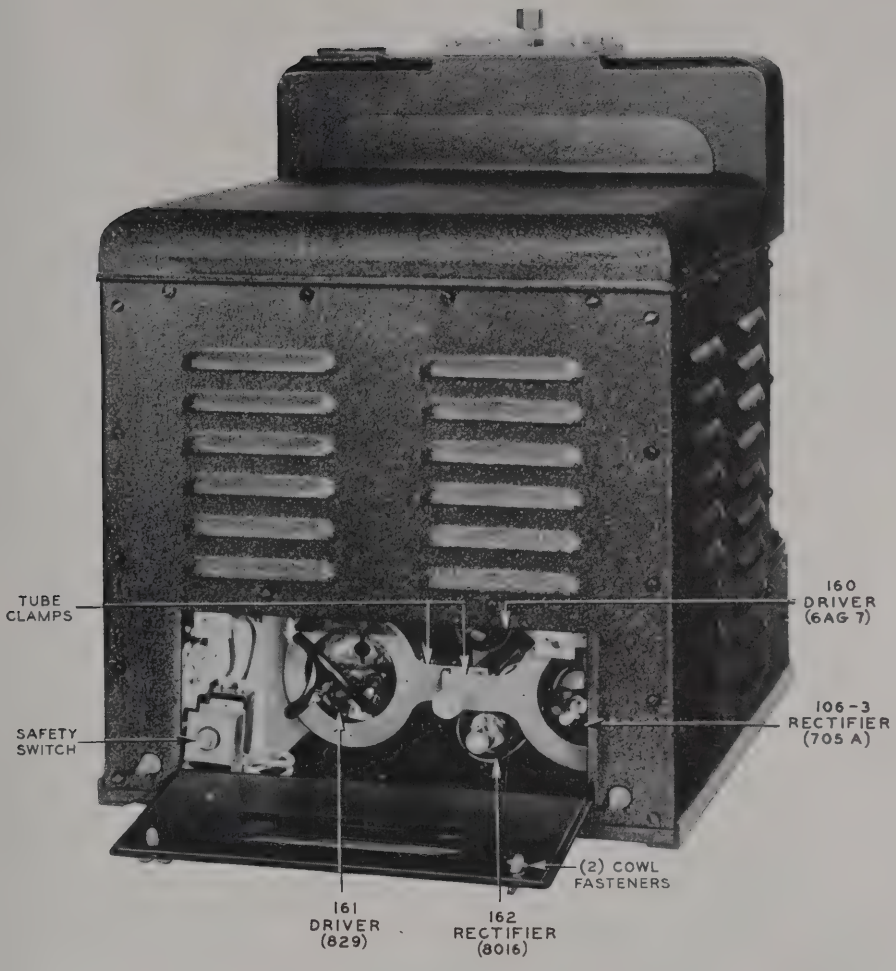

Figure 23. Modulator Unit MD-2/TPS-1, rear view showing vacuum tube compartment.

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c. Rectifiers. Single-wave rectifier tubes 162 and 106-3 (fig. 22) produce —675 volts and +1,200 volts, respectively, for operation of the multivibrator and pulse amplifier tubes. To produce the high voltage required for the pulse, a voltage doubler rectifier composed of tubes 106-1 and 106-2 is employed. Transformer 109 produces high voltage at 10 kilovolts for rectification and heater voltages for the tubes. Tube 106-1 rectifies the positive half of the alternating wave to +10 kilovolts direct current and tube 106-2, the negative half, to —10 kilovolts direct current. The output of tube 106-2 is grounded so that the output of tube 106-1 is is 20 kilovolts above ground. The high voltages require high insulation in the transformer which is immersed in oil in a separate compartment.

d. Protective Features. (1) Overload relay 151 (shunted by resistor 102) will be operated if the average current drawn from the high-voltage rectifier exceeds about 55 milliamperes.

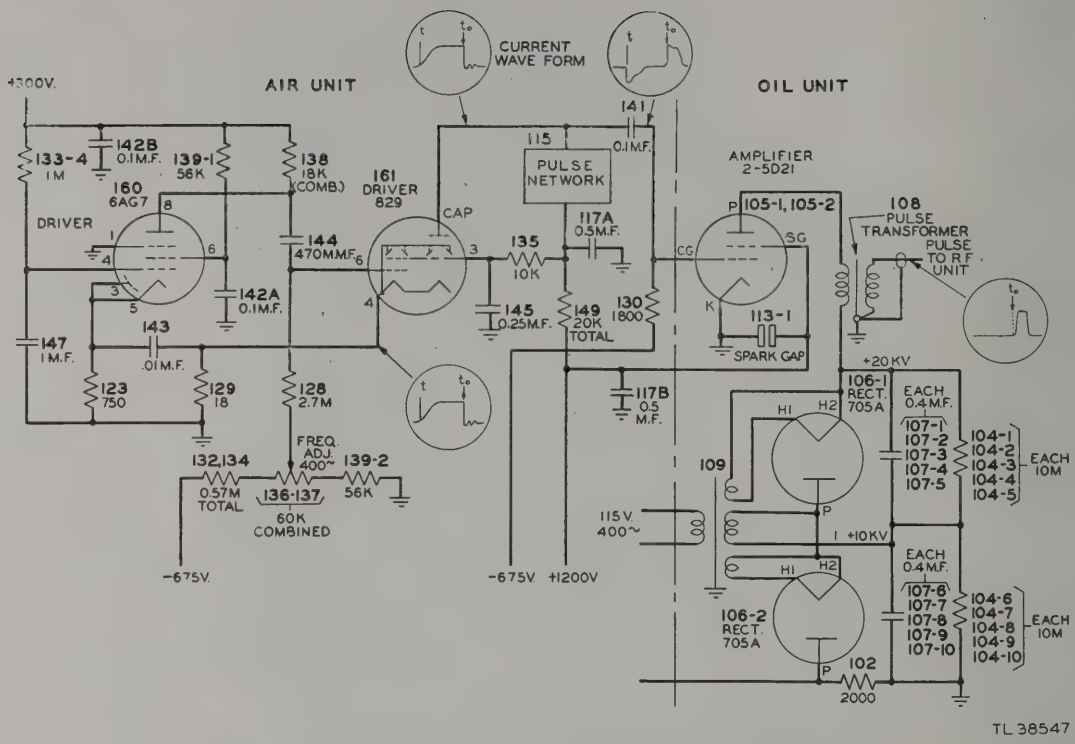

Figure 24. Modulator Unit MD-2/TPS-1, simplified schematic diagram.

Operation of this relay opens the circuit of the transmitter control relay in the indicator unit, cutting off power from high-voltage rectifier.

(2) Safety switch 157 opens when the door to the air unit tube compartment is opened (fig. 23). This switch has two contacts; one opens the 115-volt 400-cycle supply to the modulator and the other opens the circuit normally controlled by the overload relay.

11. PULSE TRANSFORMER.

Pulse transformer 1, shown in figure 25, steps up the peak voltage of the pulse from about 4,000 volts to about 18,000 volts in the double secondary winding (terminals 4 and 6 for transmission to the magnetron). Capacitor 32 and resistor 49 (fig. 29) give a slight slope to the front of the pulse wave which results in better performance of the magnetron. An electrostatic shield, which is used as a third winding, picks up a part of the pulse energy and transmits it (over terminals A and C of the orange connector) to the indicator circuit for timing the sweeps and range markers on the oscilloscopes.

12. MAGNETRON.

The high-voltage pulses are applied to the cathode of magnetron 4 (figs. 26 and 27) causing it to oscillate and produce high-frequency energy which is picked up by a loop in the magnetron and transmitted over the coaxial transmission to the antenna. The output loop of the magnetron is coupled to the coaxial transmission line without a metallic connection as shown in the sectional view (fig. 28). The filament voltage for the magnetron is supplied through the windings of transformer 1 by transformer 10. A blower operated also from transformer 10 cools the magnetron.

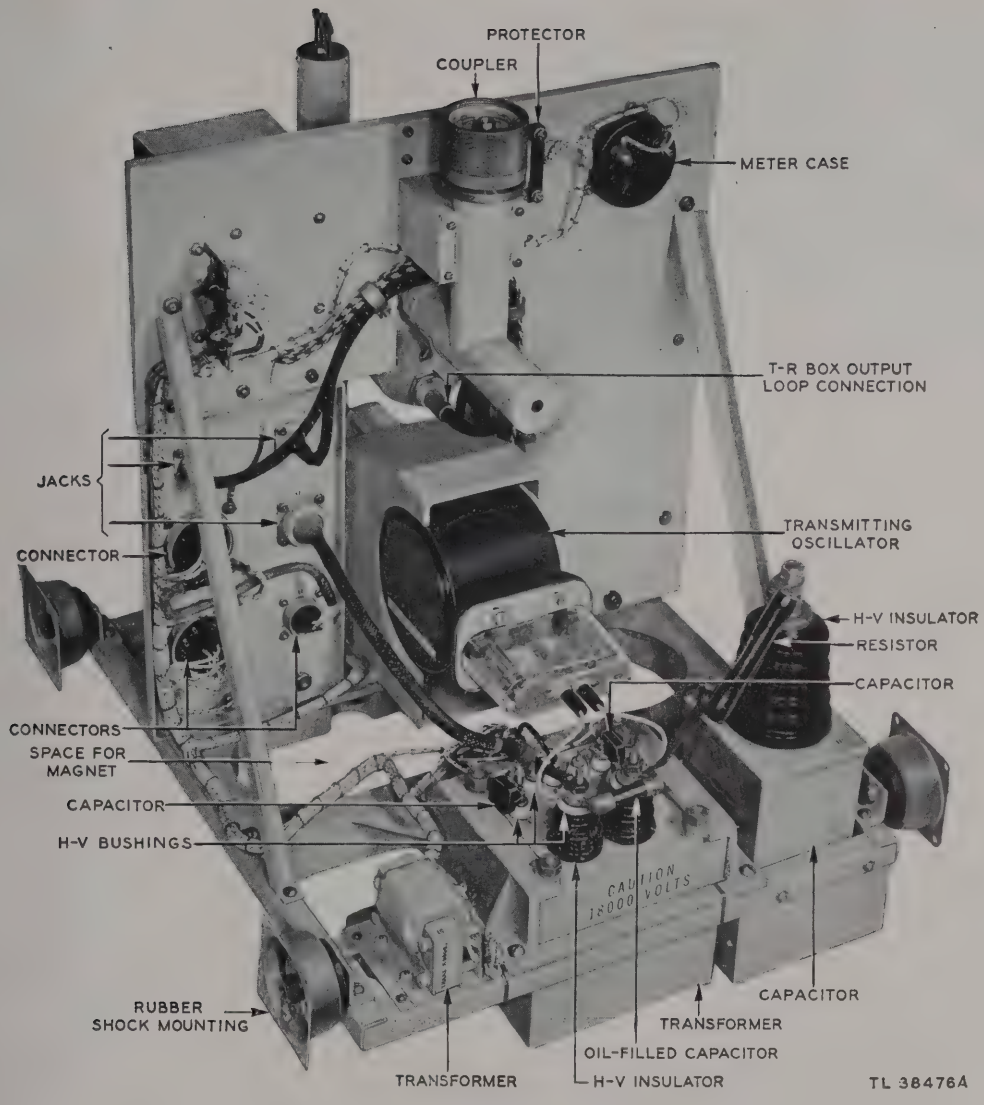

Figure 25. Radio-Frequency Unit RF-1/TPS-1, rear view.

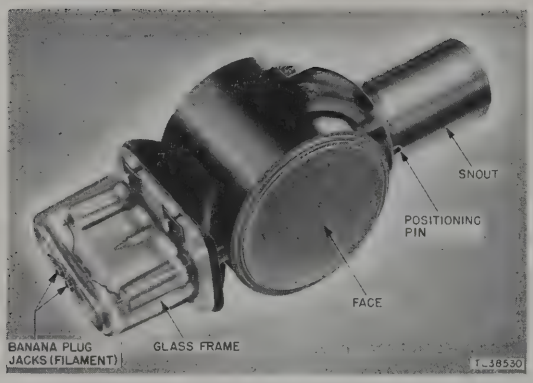

Figure 26. Magnetron.

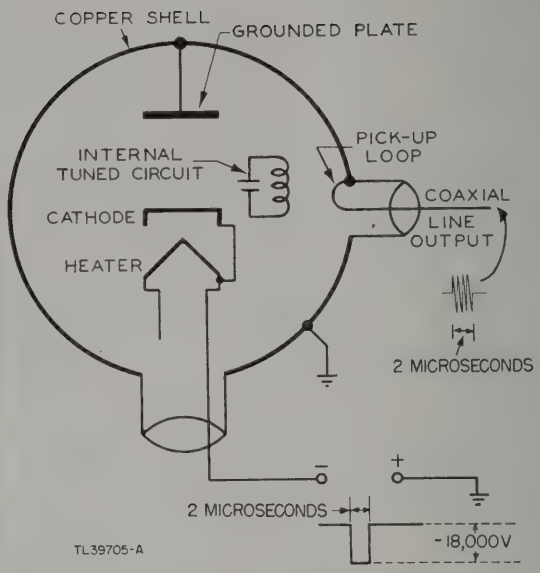

Figure 27. Magnetron, simplified equivalent circuit.

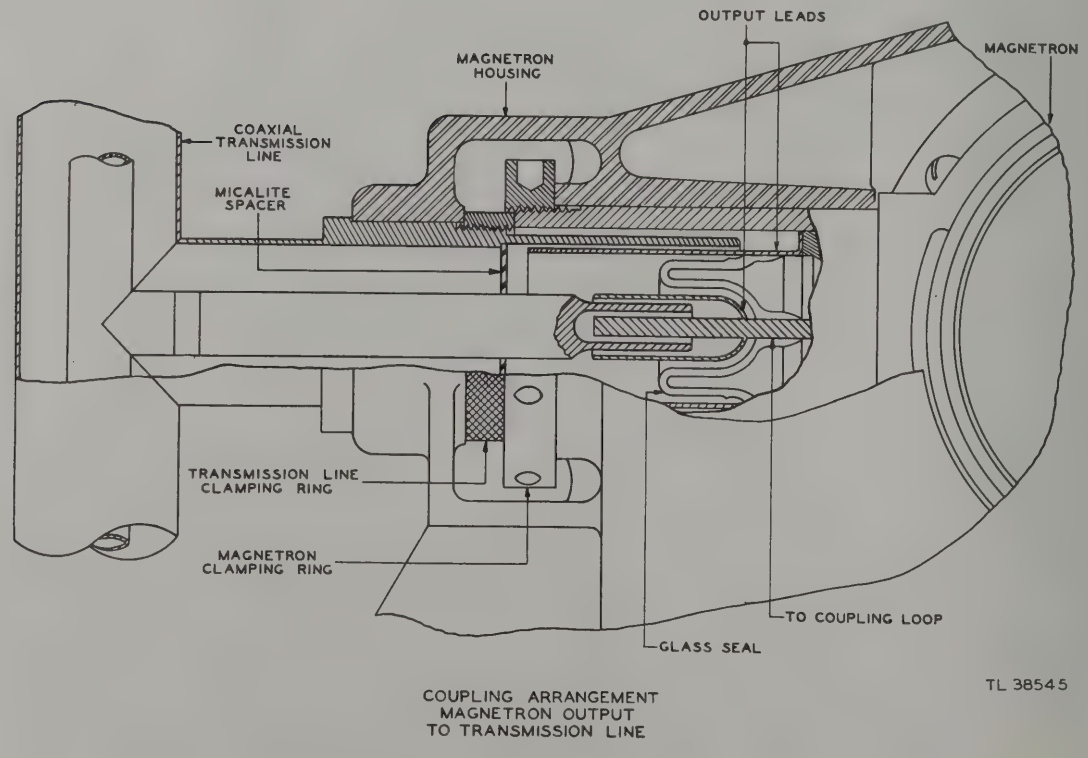

Figure 28. Magnetron output coupling to transmission line.

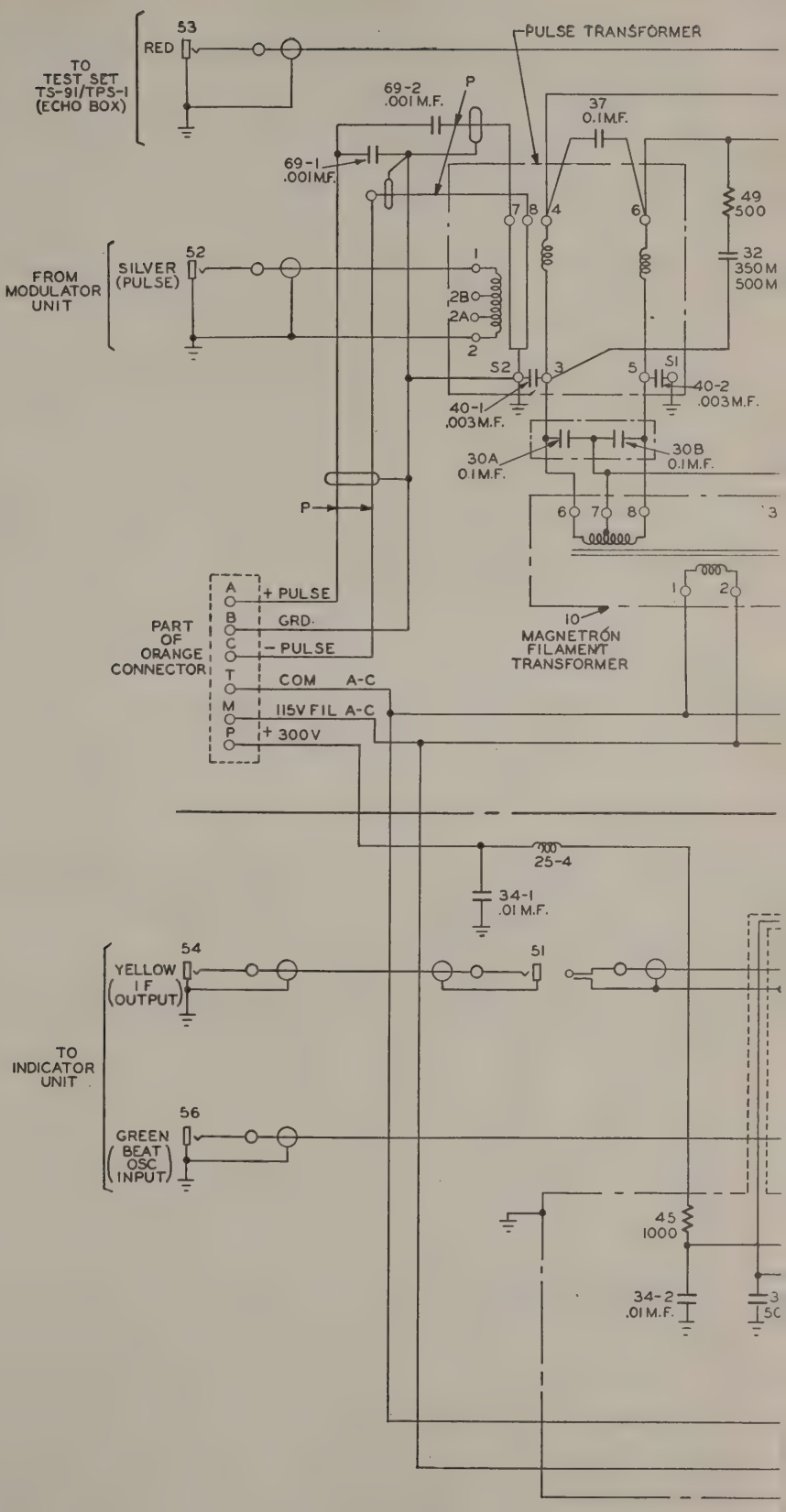

Figure 29. Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

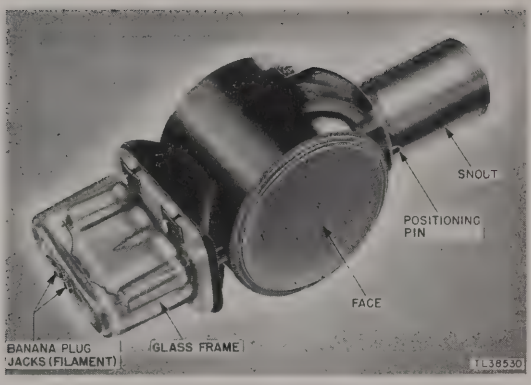

Figure 26. Magnetron.

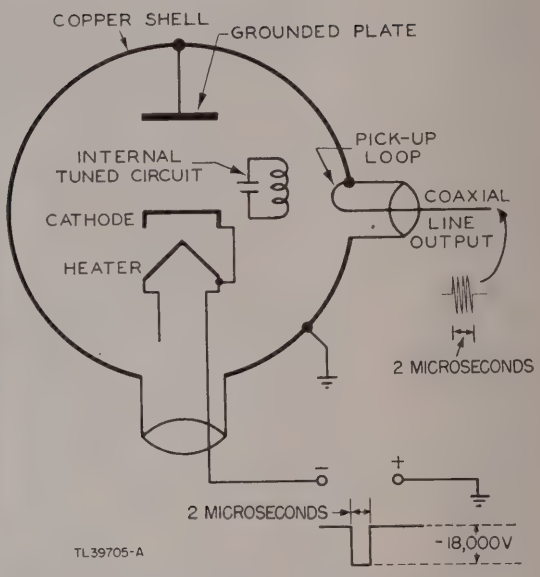

Figure 27. Magnetron, simplified equivalent circuit.

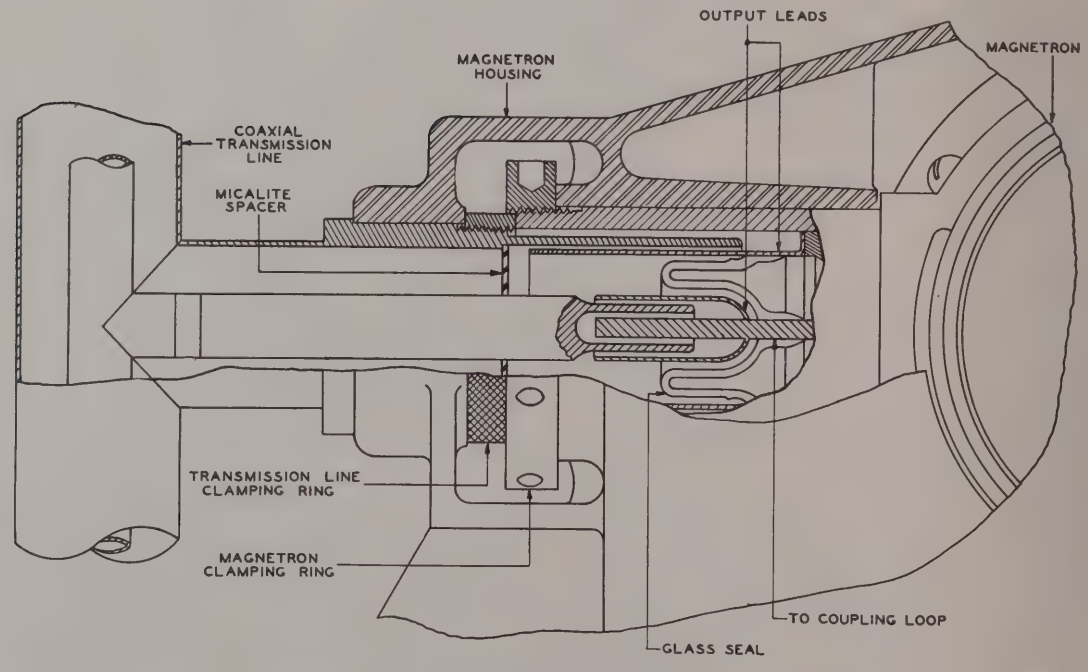

Figure 28. Magnetron output coupling to transmission line.

APP. PART NO.	NO. REQ.	DESCRIPTION	NAME	MADE BY OR EQUIVALENT
1	1	D-164672	INPUT TRANS	WESTERN ELECTRIC CO.
3	1	D-164230	MAGNET	
4	1	5J TYPE (MAGNETRON)	VACUUM TUBE	
5	1		LINE COUPLING	
6	1		IMPEDANCE MATCHING TUNING STUB	
7	1			
8	1		TEE ASSEMBLY	
10	1	KS-8983	MAG. FIL. TRANS.	
11	1	KS-8980	FIL. TRANS.	
12	1	MR35W030 D-C MA. ASA SPEC. C39.2-1943	MILLIAMETER	
13	1	KS-5992 L-02 & L-22	BLOWER	UNITED CINEPHONE CO.
16	1	TYPE 26	PROTECTOR BLOCK	WESTERN ELECTRIC CO.
17	1	TYPE 27		
18	1	KS-5991 L-01	MOTOR	EASTERN AIR DEVICES CO.
19	1	KS-9119	AUTO TRANS	WESTERN ELECTRIC CO
20	4	D-162582	CAPACITOR	
21	2	ES-803911	AMPLIFIER	
22	1	ES-803910	MODULATOR	
23	3	ES-803913-2	V.T. MTG. ASSEMBLY	
24	1	ESO-824133-2	R.F. CHOKE	
25	4	ES-804107-2		
26	6	CM20A511K	CAPACITOR	SEE KS-9112
27	1	5MMF ± 0.5 TYPE NPOK5		ERIE RESISTOR CORP.
29	1	ESO-803934-2		WESTERN ELECTRIC CO.
30	1	0.1-0.1MF+20%-10% TYPE DYR 6011		CORNELL DUBILIER CORP.
31	1	0.5MF+20%-5% TYPE DYR 6050		
32	1	D-166066		WESTERN ELECTRIC CO.
33	6	500 MMF. ± 5% TYPE N470F500		ERIE RESISTOR CORP.
34	3	0.01 MF ± 20% TYPE 689		AEROVOX CO.
37	1	D-163150 0.1MF		WESTERN ELECTRIC CO.
38	1	YZ-RQ 41	SWITCH	MICRO SWITCH CORP.
39	3	P-371196	TERMINAL	WESTERN ELECTRIC CO.
40	2	CN35A302	CAPACITOR	SEE KS-9112
42	2	600Ω ± 20% PER ES-691122-57	POTENTIOMETER	ALLEN BRADLEY CO.
43	1	1500Ω ± 20% PER ES-691122-56		
44	3	100Ω ± 10% TYPE EB (1/2W)	RESISTOR	
45	1	1000Ω ± 10% TYPE BT (2W)	RESISTOR	INTERNATIONAL RESISTOR CO.
46	2	5600Ω ± 20% TYPE GB (1W)		ALLEN BRADLEY CO.
47	1	12000Ω ± 10% TYPE BT (2W)		INTERNATIONAL RESISTOR CO.
48	1	1000Ω ± 20% TYPE GB (1W)		ALLEN BRADLEY CO.
49	1	500Ω ± 10% CAT. NO. 2009 (50W)		OHMITE MFG. CO. INC.
50	1	D-163446	PLUG	WESTERN ELECTRIC CO.
51	1	D-163447	JACK	
52	1	D-164190 (1'3½" LG)	CABLE & JACK	
53	1	D-163476	JACK	
54	1	D-164459	JACK	
56	1	D-163474	JACK	
58	1	AN-3102-20-4P	CONNECTOR	AMERICAN PHENOLIC CORP.
60	1	AN-3102-36-1P POS. 2		
61	1	AN-3102-36-1P		
62	1	ESO-804288-2	COUPLING	WESTERN ELECTRIC CO.
65	5	1000Ω ± 10% TYPE EB (1/2W)	RESISTOR	ALLEN BRADLEY CO.
66	3	47Ω ± 10% TYPE BW (1/2W)		INTERNATIONAL RESISTOR CO.
67	1	500 MMF ± 10% TYPE N750D500	CAPACITOR	ERIE RESISTANCE CO.
68	2	0.25-.025+20%-10% TYPE DYR6022		CORNELL-DUBILIER CORP.
69	2	0.001 MF ± 20% TYPE MP4101		SOLAR MFG. CORP.
70	1	ES-807757	T-R BOX	WESTERN ELECTRIC CO.
71	3	GL-446A	VACUUM TUBE	GENERAL ELECTRIC CO.
73	1	1B23		WESTERN ELECTRIC CO.

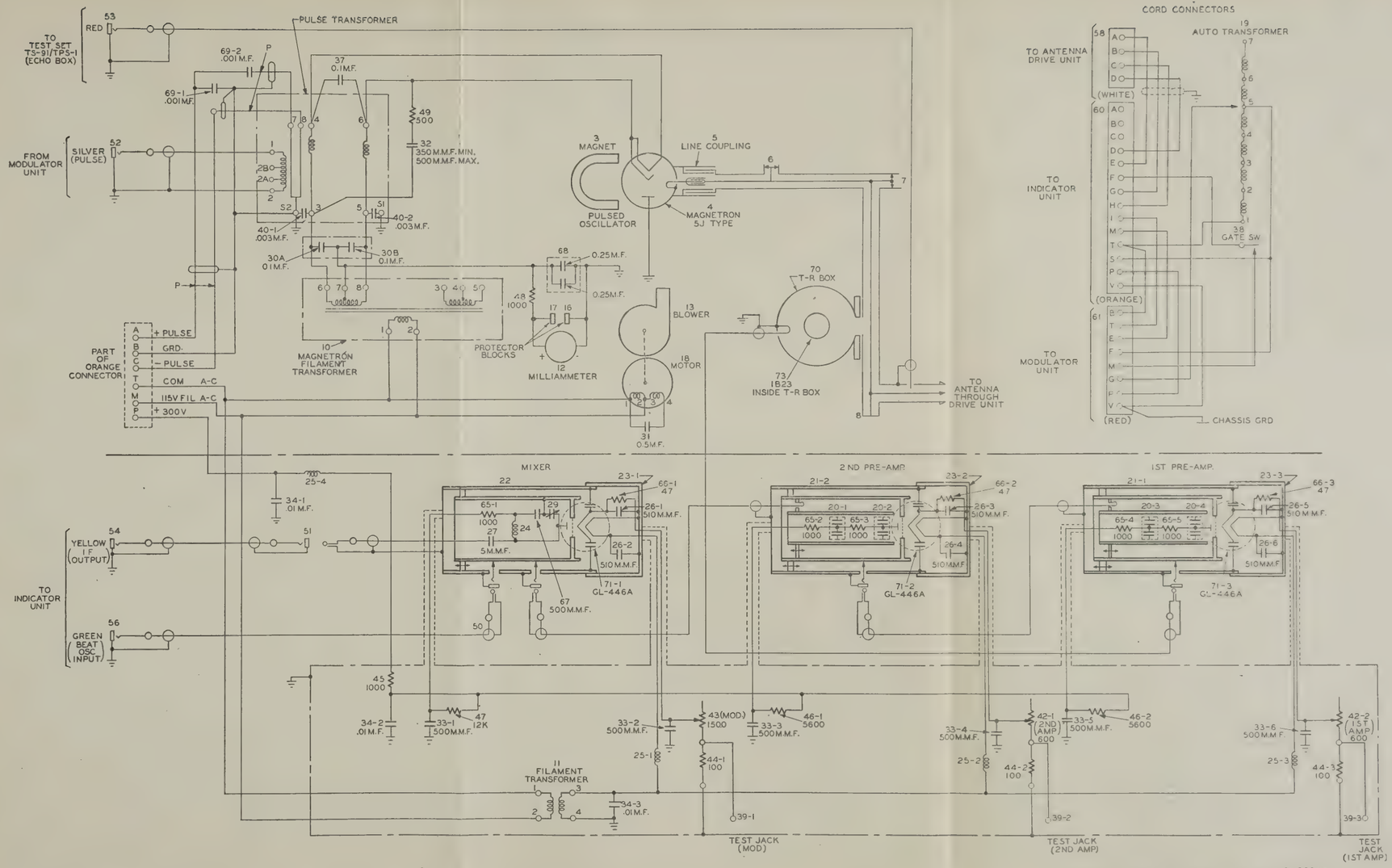

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Figure 29. Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

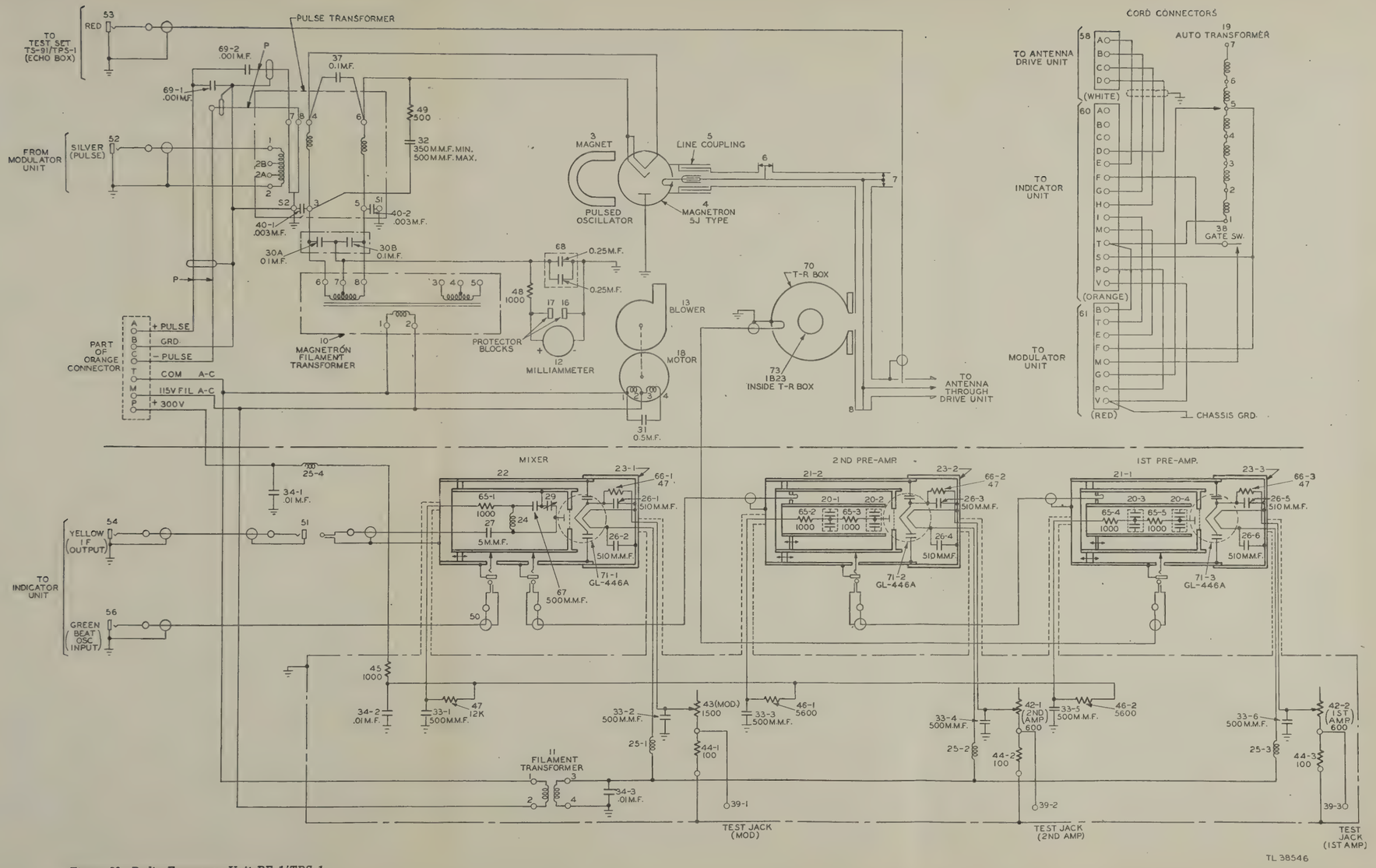

Figure 29. Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

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5	1		LINE COUPLING	
6	1		IMPEDANCE MATCHING TUNING STUB	
7	1			
8	1		TEE ASSEMBLY	
10	1	KS-8983	MAG. FIL. TRANS.	
11	1	KS-8980	FIL. TRANS.	
12	1	MR35W030 D-C MA, ASA SPEC. C39.2-1943	MILLIAMETER	
13	1	KS-5992 L-02 & L-22	BLOWER	UNITED CINEPHONE CO.
16	1	TYPE 26	PROTECTOR BLOCK	WESTERN ELECTRIC CO.
17	1	TYPE 27		
18	1	KS-5991 L-01	MOTOR	EASTERN AIR DEVICES CO.
19	1	KS-9119	AUTO TRANS	WESTERN ELECTRIC CO.
20	4	D-162582	CAPACITOR	
21	2	ES-803911	AMPLIFIER	
22	1	ES-803910	MODULATOR	
23	3	ES-803913-2	V.T. MTG. ASSEMBLY	
24	1	ES0-824133-2	R.F. CHOKE	
25	4	ES-804107-2		
26	6	CM20A511K	CAPACITOR	SEE KS-9112
27	1	5MMF ± 0.5 TYPE NPOK5		ERIE RESISTOR CORP.
29	1	ES0-803934-2		WESTERN ELECTRIC CO.
30	1	0.1-0.1MF+20%-10% TYPE DYR 6011		CORNELL DUBILIER CORP.
31	1	0.5MF+20%-5% TYPE DYR 6050		
32	1	D-166066		WESTERN ELECTRIC CO.
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45	1	1000W ± 10% TYPE BT (2W)	RESISTOR	INTERNATIONAL RESISTOR CO.
46	2	5600W ± 20% TYPE GB (1W)		ALLEN BRADLEY CO.
47	1	12000W ± 10% TYPE BT(2W)		INTERNATIONAL RESISTOR CO.
48	1	1000W ± 20% TYPE GB (1W)		ALLEN BRADLEY CO.
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53	1	D-163476	JACK	
54	1	D-164459	JACK	
56	1	D-163474	JACK	
58	1	AN-3102-20-4P	CONNECTOR	AMERICAN PHENOLIC CORP.
60	1	AN-3102-36-1P POS.2		
61	1	AN-3102-36-1P		
62	1	ES0-804288-2*	COUPLING	WESTERN ELECTRIC CO.
65	5	1000W ± 10% TYPE EB (1/2W)	RESISTOR	ALLEN BRADLEY CO.
66	3	47W ± 10% TYPE BW (1/2W)		INTERNATIONAL RESISTOR CO.
67	1	500 MMF ± 10% TYPE N750D500	CAPACITOR	ERIE RESISTANCE CO.
68	2	0.25-0.25+20%-10% TYPE DYR6022		CORNELL-DUBILIER CORP.
69	2	0.001 MF ± 20% TYPE MP4101		SOLAR MFG. CORP.
70	1	ES-807757	T-R BOX	WESTERN ELECTRIC CO.
71	3	GL-446A	VACUUM TUBE	GENERAL ELECTRIC CO.
73	1	1B23		WESTERN ELECTRIC CO.

SECTION IV
RADIO-FREQUENCY SYSTEM

13. INTRODUCTION.

From the magnetron, the high-frequency radio energy is carried over a coaxial transmission line to the projector of the antenna. The transmission line is shown in figure 30. It comprises a vertical tuned portion in the radio-frequency (r-f) unit, a horizontal portion on which the T-R box is mounted, a second vertical portion which forms the spindle on which the antenna is mounted, and a flexible transmission line connecting to the projector of the antenna. A schematic diagram of the r-f system is shown in figure 31.

14. TRANSMISSION LINE.

a. The vertical portion of the transmission line in the r-f unit (fig. 32) is tuned by two adjustable stubs at top and bottom. The T-R box (fig. 33), which acts as a gate to prevent more than a small portion of the outgoing radio energy from reaching the receiver and to transmit the incoming signals to the receiver, is clamped over an opening in the horizontal portion of the transmission line in the r-f unit. Five positions for the T-R box are marked on the transmission line corresponding to the five magnetrons which may be used to give five different frequency bands. The T-R box contains a 1B23 vacuum tube which has no electrical connections but breaks down when radio energy is sent out, detuning the T-R box and protecting the receiver.

b. The vertical portion of the transmission line contained in the antenna spindle revolves with the antenna. The lower end of this portion is coupled to the r-f unit and contains a slip joint to permit the upper part to revolve. The center conductor is removable and is

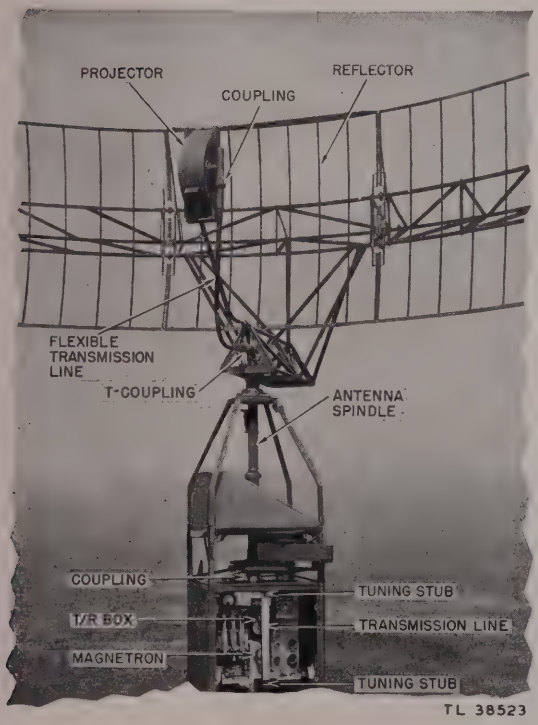

Figure 30. Location of r-f system parts.

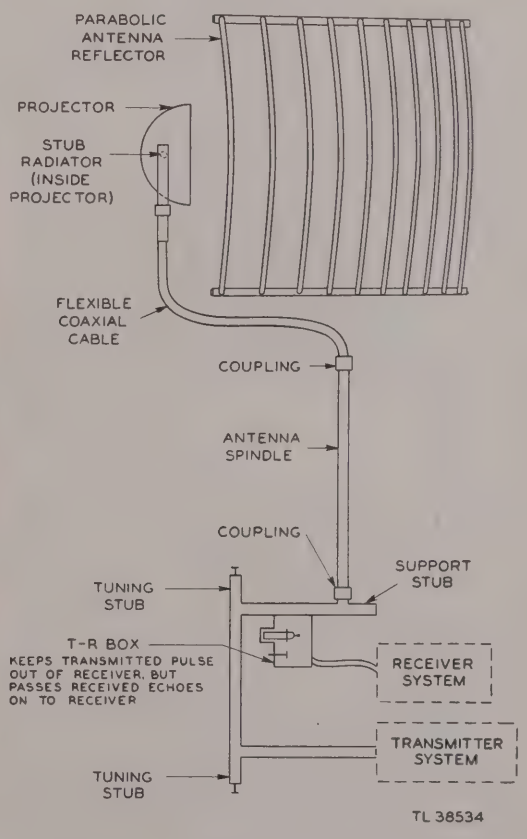

Figure 31. R-f system, schematic diagram.

PP. ART NO.	NO. REQ.	DESCRIPTION	NAME	MADE BY OR EQUIVALENT
1	1	D-164672	INPUT TRANS	WESTERN ELECTRIC CO.
3	1	D-164230	MAGNET	
4	1	5J TYPE (MAGNETRON)	VACUUM TUBE	
5	1		LINE COUPLING	
6	1		IMPEDANCE MATCHING TUNING STUB	
7	1			
8	1		TEE ASSEMBLY	
10	1	KS-8983	MAG. FIL. TRANS.	
11	1	KS-8980	FIL. TRANS.	
12	1	MR35W030 D-C MA, ASA SPEC. C39.2-1943	MILLIAMETER	
13	1	KS-5992 L-02 & L-22	BLOWER	UNITED CINEPHONE CO.
16	1	TYPE 26	PROTECTOR BLOCK	WESTERN ELECTRIC CO.
17	1	TYPE 27		
18	1	KS-5991 L-01	MOTOR	EASTERN AIR DEVICES CO.
19	1	KS-9119	AUTO TRANS	WESTERN ELECTRIC CO
20	4	D-162582	CAPACITOR	
21	2	ES-803911	AMPLIFIER	
22	1	ES-803910	MODULATOR	
23	3	ES-803913-2	V.T. MTG. ASSEMBLY	
24	1	ESO-824133-2	R.F. CHOKE	
25	4	ES-804107-2		
26	6	CM20A511K	CAPACITOR	SEE KS-9112
27	1	5MMF ± 0.5 TYPE NPOK5		ERIE RESISTOR CORP.
29	1	ESO-803934-2		WESTERN ELECTRIC CO.
30	1	0.1-0.1 MF +20%-10% TYPE DYR 6011		CORNELL DUBILIER CORP.
31	1	0.5M.F +20%-5% TYPE DYR 6050		
32	1	D-166066		WESTERN ELECTRIC CO.
33	6	500 MMF. ± 5% TYPE N470F500		ERIE RESISTOR CORP.
34	3	0.01 MF ± 20% TYPE 689		AEROVOX CO.
37	1	D-163150 0.1 MF		WESTERN ELECTRIC CO.
38	1	YZ-RQ 41	SWITCH	MICRO SWITCH CORP.
39	3	P-371196	TERMINAL	WESTERN ELECTRIC CO.
40	2	CN35A302	CAPACITOR	SEE KS-9112
42	2	600^{W} ± 20% PER ES-691122-57	POTENTIOMETER	ALLEN BRADLEY CO.
43	1	1500^{W} ± 20% PER ES-691122-56		
44	3	100^{W} ± 10% TYPE EB (1/2W)	RESISTOR	
45	1	1000^{W} ± 10% TYPE BT (2W)	RESISTOR	INTERNATIONAL RESISTOR CO.
46	2	5600^{W} ± 20% TYPE GB (1W)		ALLEN BRADLEY CO.
47	1	12,000^{W} ± 10% TYPE BT (2W)		INTERNATIONAL RESISTOR CO.
48	1	1000^{W} ± 20% TYPE GB (1W)		ALLEN BRADLEY CO.
49	1	500^{W} ± 10% CAT. NO. 2009 (50W)		OHMITE MFG. CO. INC.
50	1	D-163446	PLUG	WESTERN ELECTRIC CO.
51	1	D-163447	JACK	
52	1	D-164190 (1'3½" LG)	CABLE & JACK	
53	1	D-163476	JACK	
54	1	D-164459	JACK	
56	1	D-163474	JACK	
58	1	AN-3102-20-4P	CONNECTOR	AMERICAN PHENOLIC CORP.
60	1	AN-3102-36-1P POS. 2		
61	1	AN-3102-36-1P		
62	1	ESO-804288-2	COUPLING	WESTERN ELECTRIC CO.
65	5	1000^{W} ± 10% TYPE EB (1/2W)	RESISTOR	ALLEN BRADLEY CO.
66	3	47^{W} ± 10% TYPE BW (1/2W)		INTERNATIONAL RESISTOR CO.
67	1	500 MMF ± 10% TYPE N750D500	CAPACITOR	ERIE RESISTANCE CO.
68	2	0.25-0.25 +20%-10% TYPE DYR6022		CORNELL-DUBILIER CORP.
69	2	0.001 MF ± 20% TYPE MP4101		SOLAR MFG. CORP.
70	1	ES-807757	T-R BOX	WESTERN ELECTRIC CO.
71	3	GL-446A	VACUUM TUBE	GENERAL ELECTRIC CO.
73	1	1B23		WESTERN ELECTRIC CO.

SECTION IV
RADIO-FREQUENCY SYSTEM

13. INTRODUCTION.

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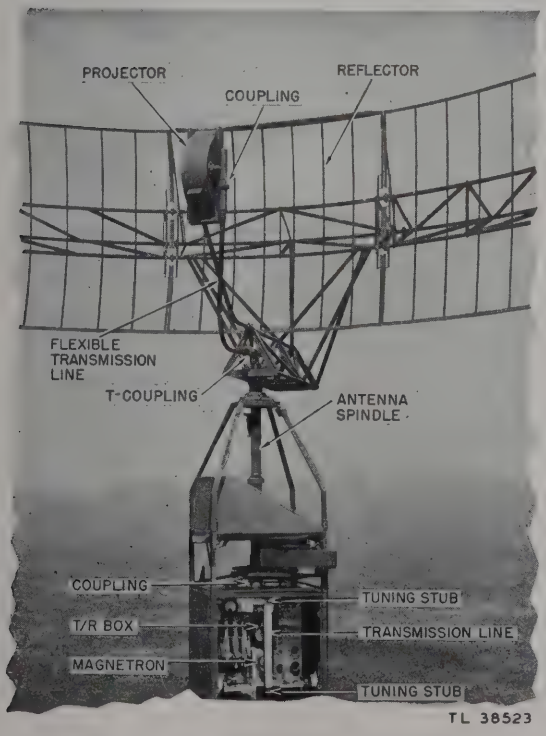

Figure 30. Location of r-f system parts.

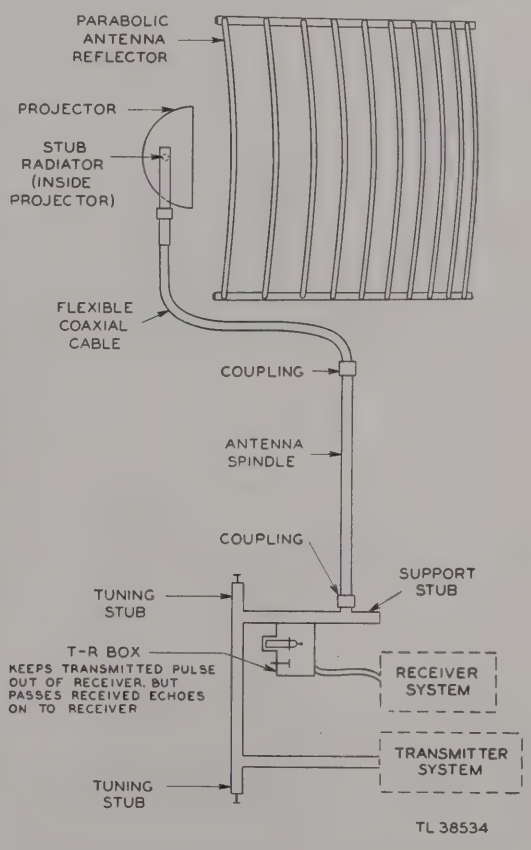

Figure 31. R-f system, schematic diagram.

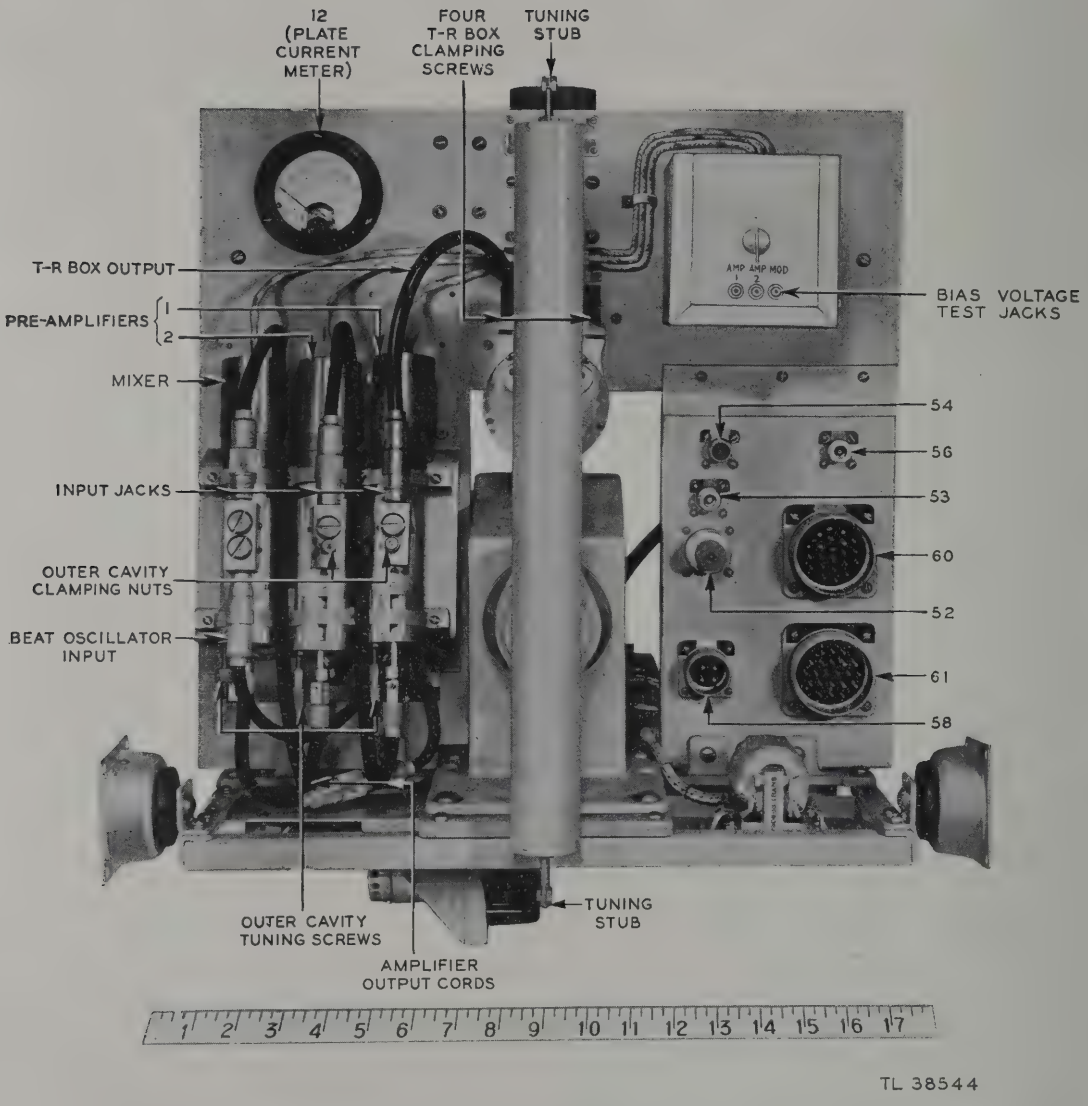

Figure 32. Radio-Frequency Unit RF-1/TPS-1, front view.

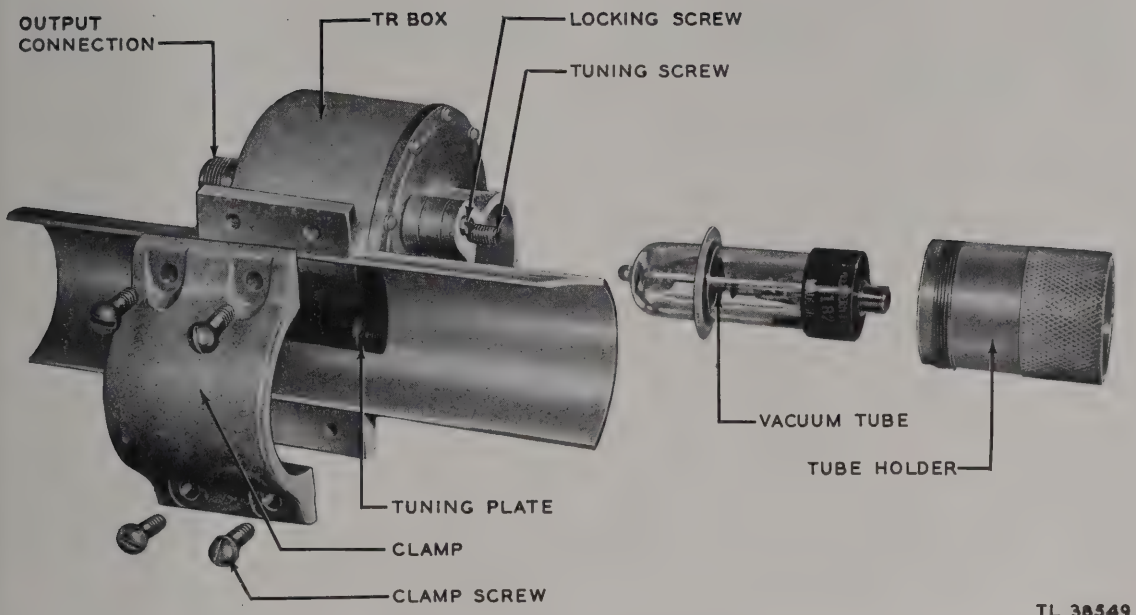

Figure 33. T-R box disassembled.

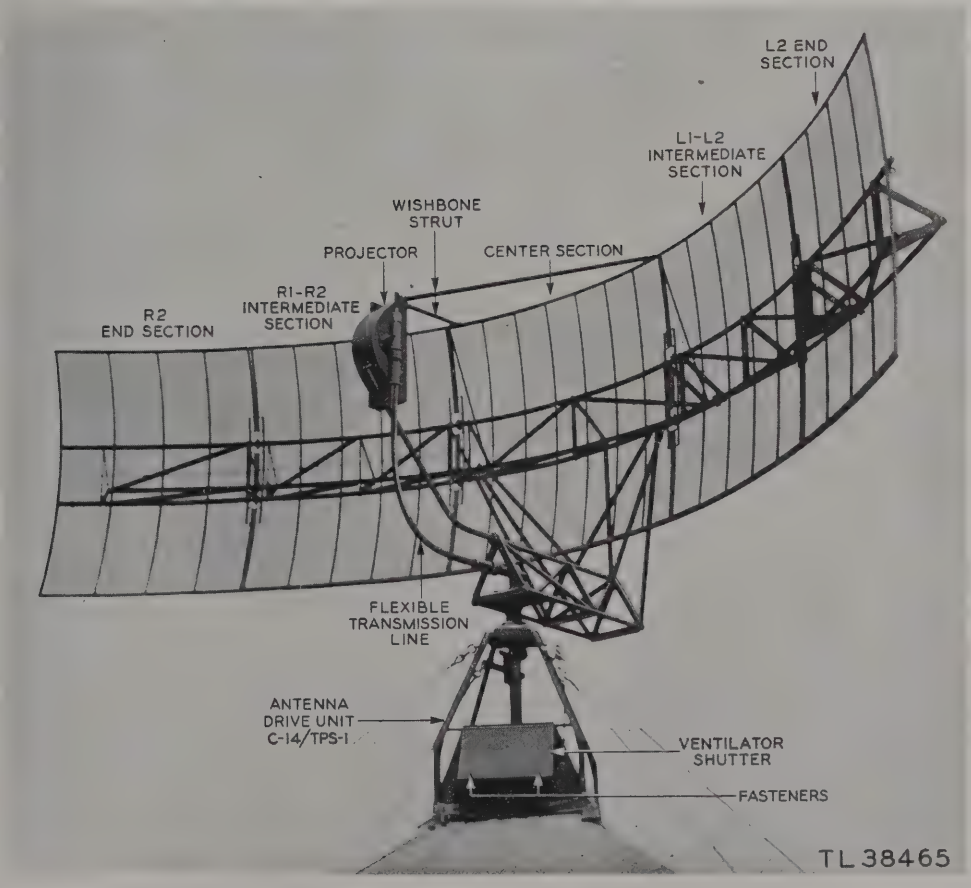

Figure 34. Antenna AS-8/TPS-1.

partly drawn out when assembling the radio set. The flexible transmission line is coupled to the upper end of this portion by a T-coupling and its upper end is coupled to a stub radiator or probe in the projector of the antenna.

15. ANTENNA (fig. 34).

The probe excites the parabolic projector (fig. 35) in much the same manner that a probe excites a waveguide. The r-f energy is directed

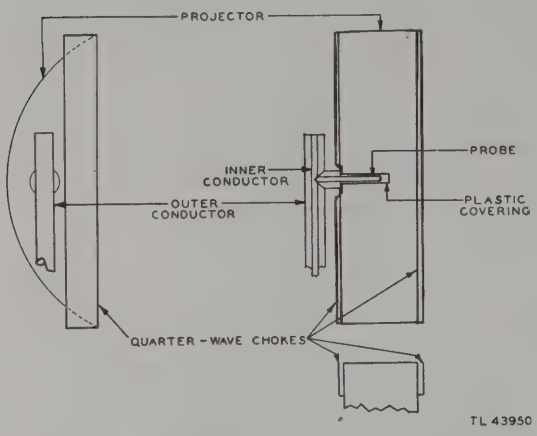

Figure 35. Antenna AS-8/TPS-1, projector.

from the projector against the reflector. Size, shape, and position of the parabolic probe and projector are such as to match the impedance of the antenna system to the coaxial line for the working range of magnetron frequencies. Quarter-wave chokes along the vertical edges of the projector serve to minimize side lobes in the antenna pattern. The parabolic reflector is composed of wire mesh on a steel frame. It concentrates the r-f energy into a beam which is narrow horizontally and wider vertically. The horizontal pattern is shown in figure 36, and the vertical pattern in a free-space field in figure 37. The narrow horizontal pattern permits determination of azimuth angles to within about 3 degrees. The vertical pattern in a free-space field is not a representation of the performance of the antenna when set up over the ground. The ground, including water areas, acts as a reflector of the radiation from the antenna directed toward it. The field intensity at any point is the resultant of the direct and the reflected radiation. The reflection is, in general, from some point within about 500 yards of the antenna, depending upon the point of observation and the character of the ground surface. The general effect of the reflected radiation is to distort the vertical beam pattern into a series of nulls and peaks resembling fingers which spread out in a vertical plane from the antenna. A typical vertical pattern for a particular set of conditions is shown in figure 38. As the height of the antenna above the area of reflection is increased, the angular separation between the nulls and peaks is decreased until in a free-space field the vertical angle of the beam embraces about 13 degrees at the point of 70 percent intensity. The comparatively wide vertical angle of the beam and the "fingers" formed by reflection make it unnecessary to tilt the antenna to cover the vertical field.

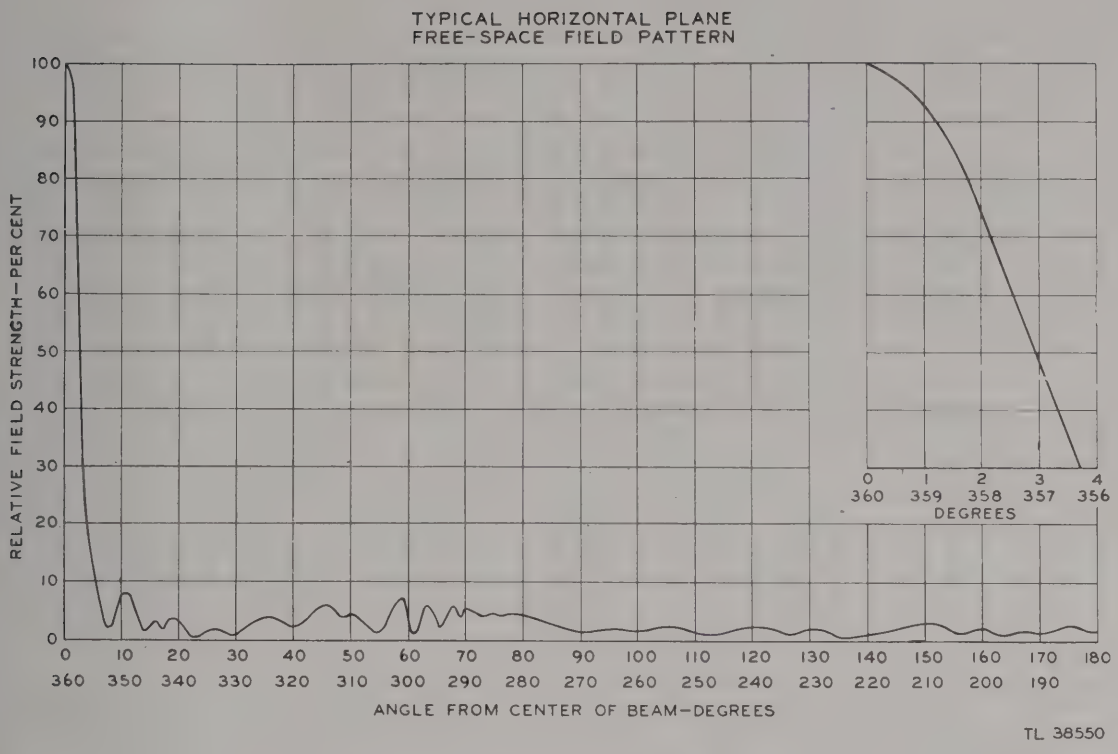

Figure 36. Horizontal field pattern of antenna.

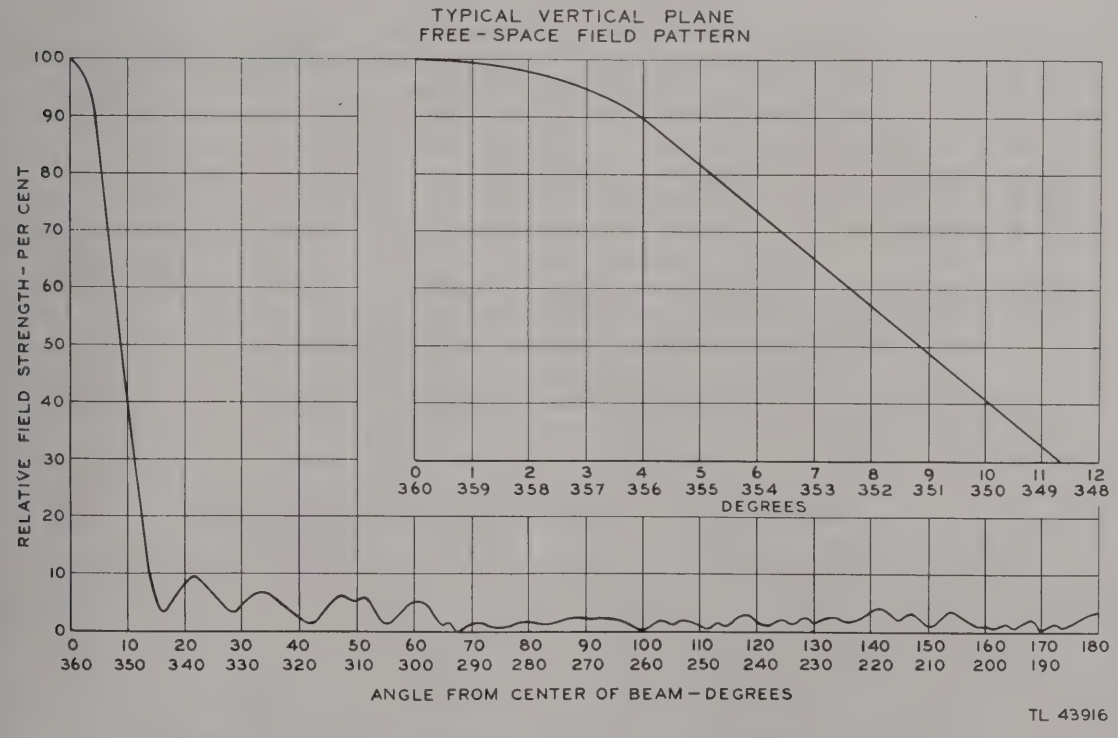

Figure 37. Vertical field pattern of antenna without ground reflections.

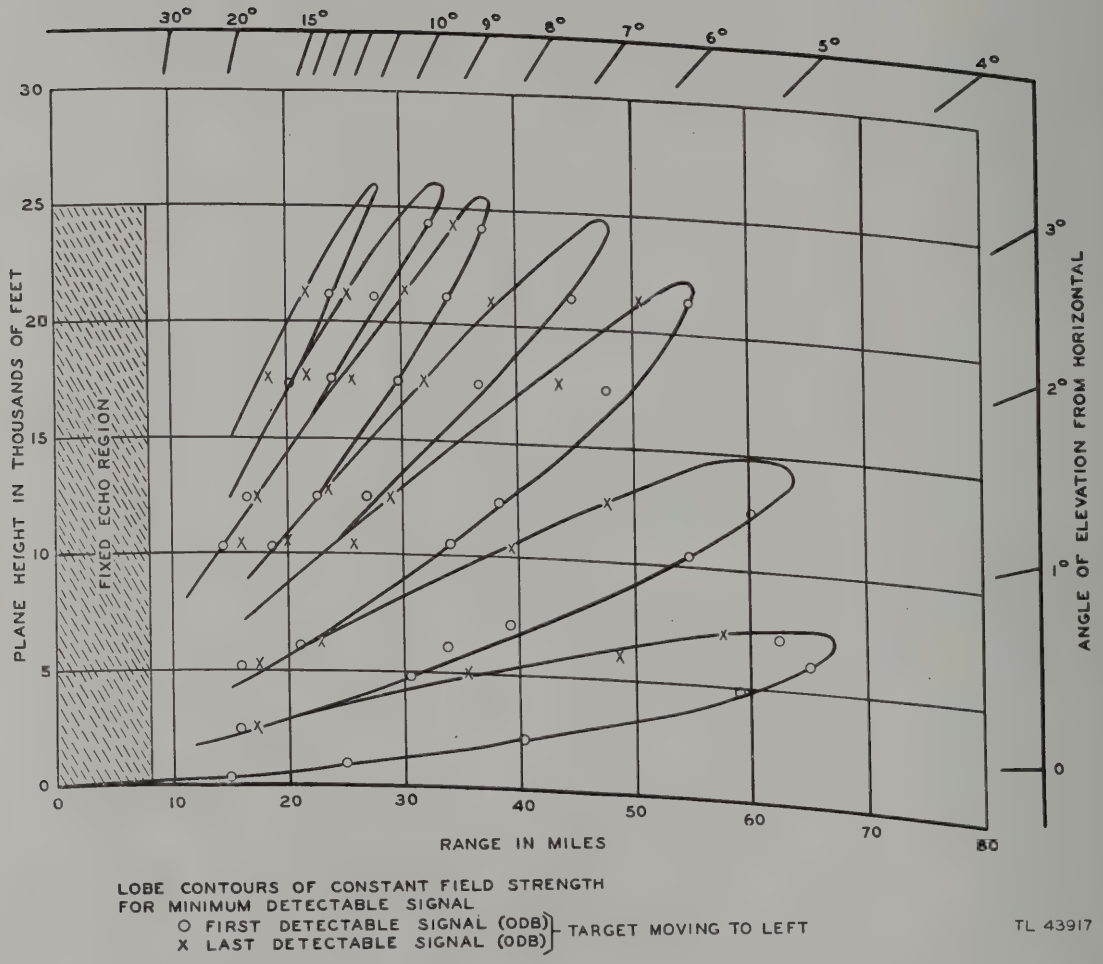

Figure 38. Vertical field pattern of antenna over a reflecting surface.

SECTION V
RECEIVER SYSTEM

16. INTRODUCTION.

The receiver system comprises two r-f preamplifiers and a mixer located in the r-f unit, together with a beat oscillator (local oscillator) and an i-f amplifier-detector which are mounted in the indicator unit. The two preamplifiers, the mixer, and the beat oscillator are similar in construction and consist of vacuum tubes with mechanically tuned cavities in the interelement circuits. Mechanically tuned cavities are used because ordinary capacitors for the high frequency would be very small and difficult to tune accurately. An assembly of this kind is shown disassembled in figure 39. Figure 40 shows a block diagram of the receiver system.

17. PREAMPLIFIERS.

The returning reflected energy received by the antenna is picked up by a loop in the T-R box and transmitted to preamplifier No. 1 (fig. 29) where it is amplified. The r-f is further amplified in preamplifier No. 2. The inputs and outputs of these preamplifiers are tuned to the radio frequency by screws which change the size of the cavities in the interelement circuits by moving slides in the cavities. The outer slide adjusts the cavity in the cathode-grid circuit, and the inner slide, the cavity in the grid-plate circuit. The amplified r-f from preamplifier No. 2 is transmitted to the mixer. This has a second input which receives energy produced by the beat oscillator (fig. 58) in the indicator

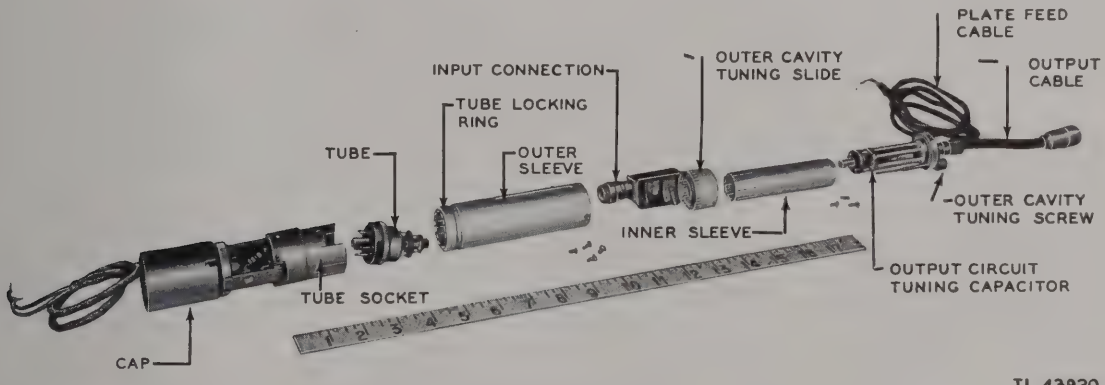

Figure 39. Mixer assembly, disassembled.

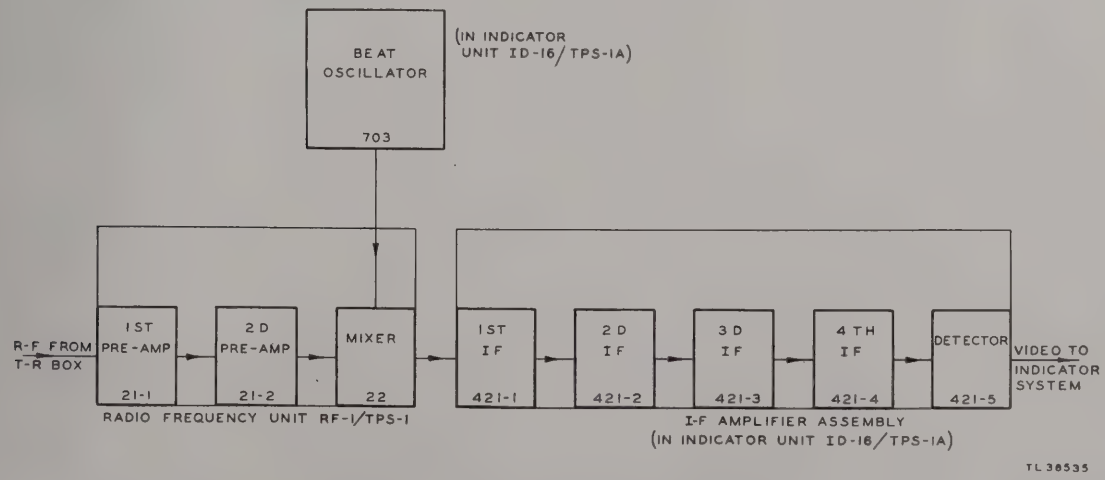

Figure 40. Receiver system, block diagram.

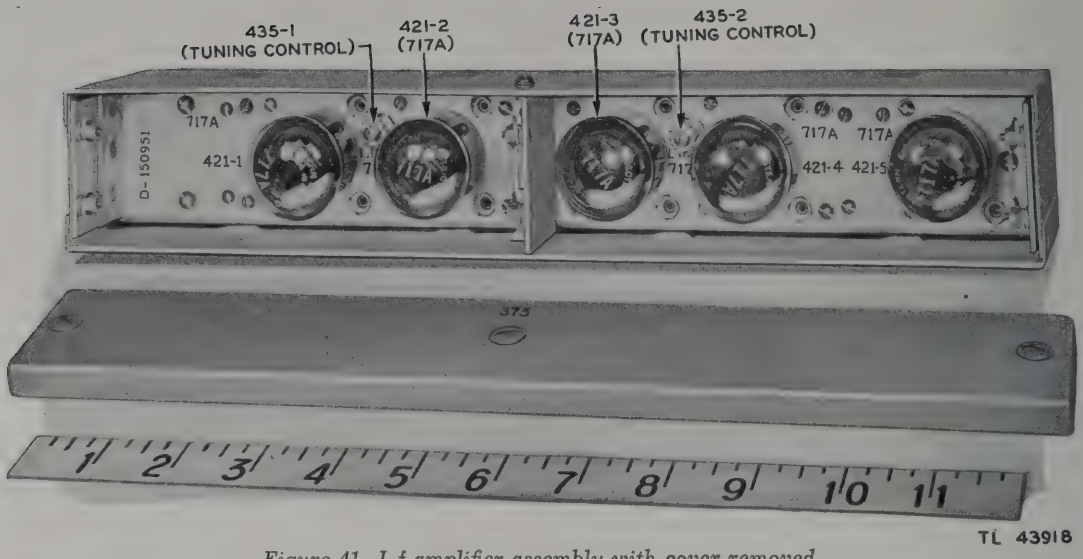

Figure 41. I-f amplifier assembly with cover removed.

unit. This beat-oscillator energy is 60 megacycles below the frequency of the received radio energy from the magnetron. When radio energy is received at the antenna, the two frequencies in the mixer produce a beat (just as two musical notes will produce a beat) of 60 megacycles, which is the intermediate frequency. The mixer (fig. 29) and the beat oscillator are tuned in the same manner as the preamplifiers. The inner cavity of the beat oscillator is adjusted by a knob marked TUNING on the face of the indicator unit.

18. I-F AMPLIFIER AND DETECTOR.

a. The i-f amplifier and detector are built as a separate subassembly (fig. 41) which plugs into a jack on the indicator chassis. The circuit (fig. 42) comprises four stages of amplification (421-1, 421-2, 421-3, and 421-4) and a detector (421-5). Transformer coupling (423, 424, 425) is provided to the first stage, between the second and third stages, and between the fourth stage and the detector. Impedance-coupling networks are used between the first and second stages and between the third and fourth stages. These consist of plate feed chokes (428-1, 428-2) capacitance-coupled to the grid circuits. The interstage couplings are tuned by adjustable slugs in self-inductance coils 435-1, 435-2, which resonate with the distributed coil capacitances. When tuned to 60 megacycles, the transmission band is about 2 megacycles wide.

b. The four stages of amplification amplify the i-f frequency produced by the beat in the mixer of the r-f unit and detector 421-5 rectifies the signal to a series of steep-fronted video pulses at the pulse rate of the modulator. Choke 429-2 in the output of the detector (from the cathode) reduces the amount of 60-megacycle current at the output.

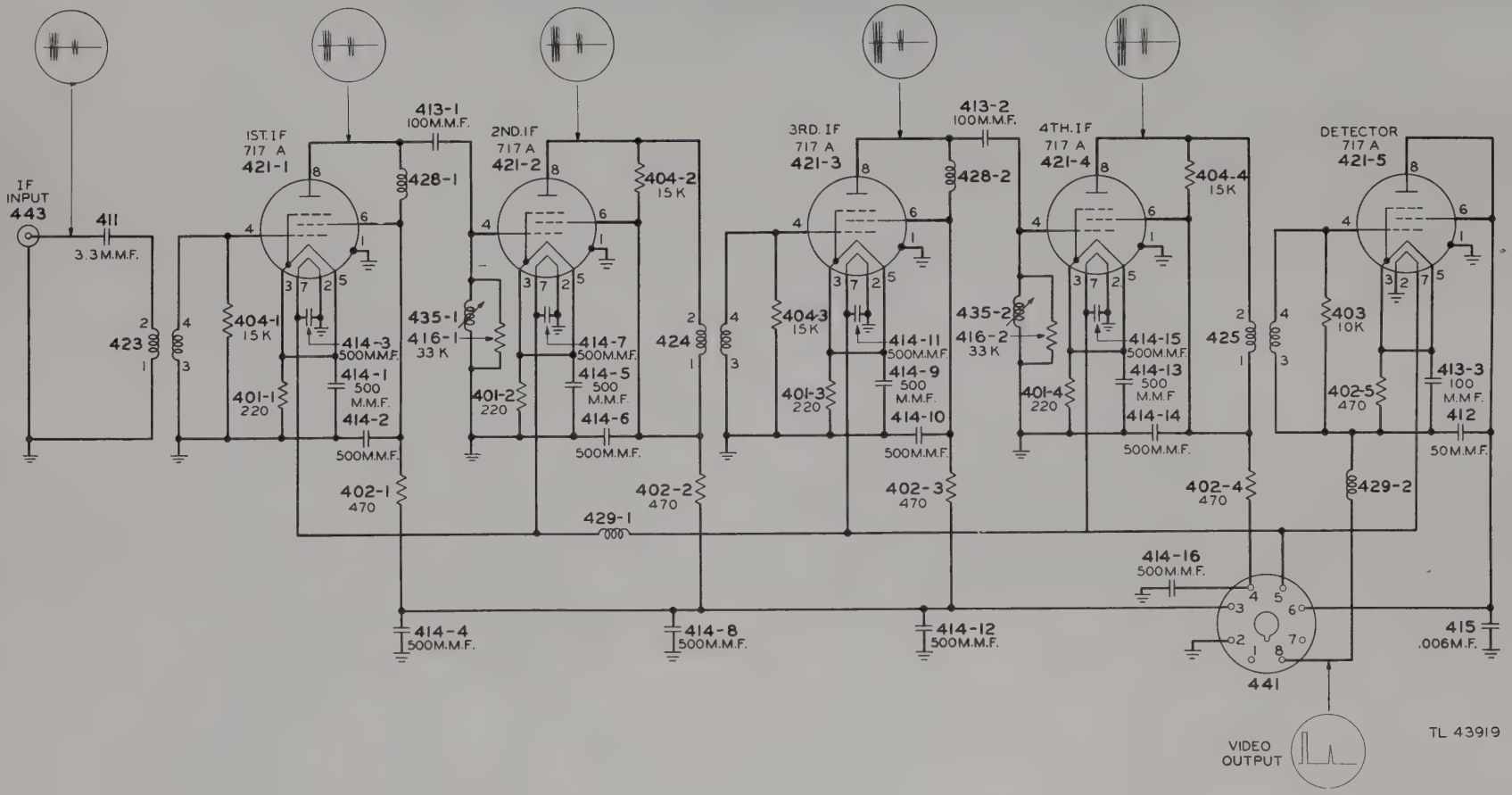

Figure 42. I-f amplifier assembly, schematic diagram.

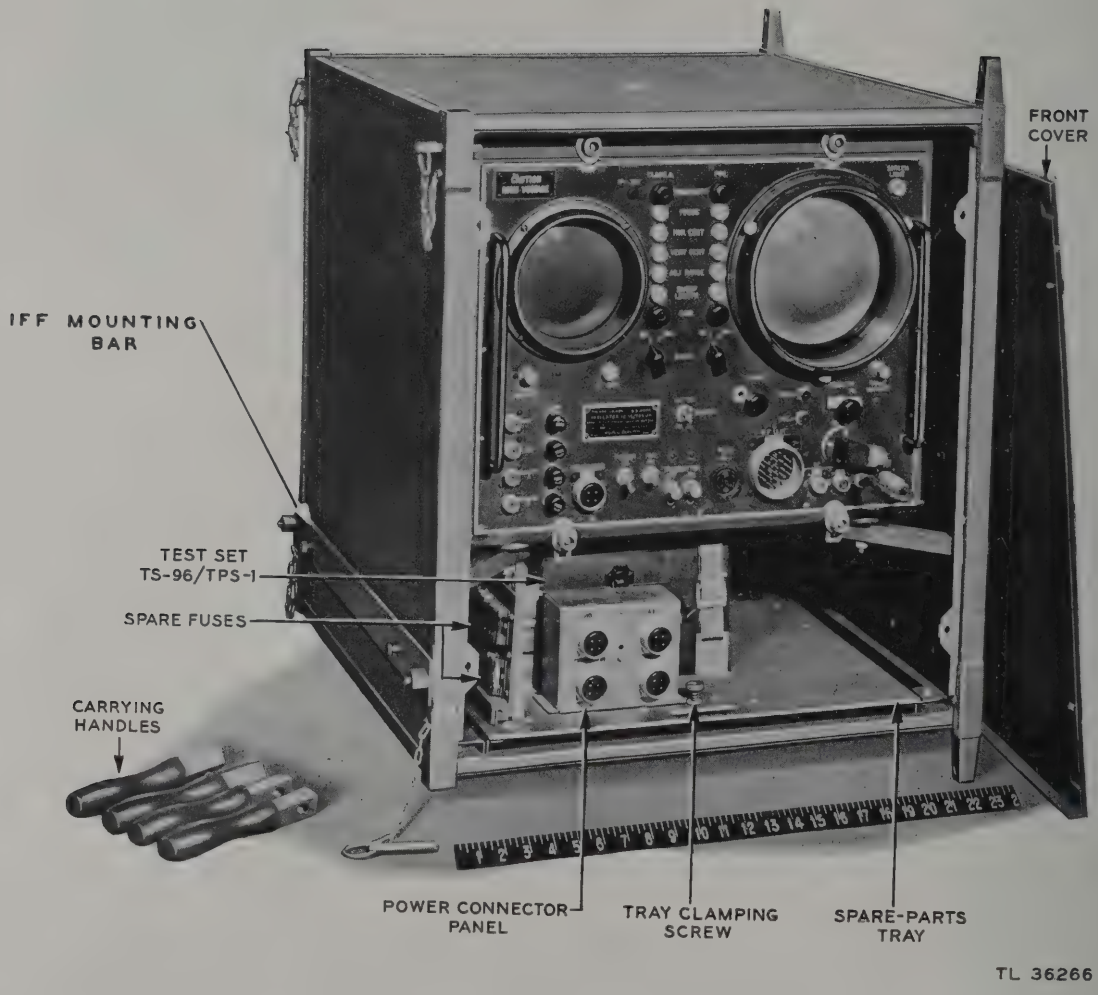

Figure 43. Tower section No. 2, showing Indicator Unit ID-16/TPS-1A in place.

SECTION VI
INDICATOR SYSTEM

19. INTRODUCTION.

The indicator system comprises a 7-inch PPI oscilloscope, a 5-inch Class A oscilloscope, a range marker circuit, and separate video amplifiers and sweep circuits for the two oscilloscopes. These circuits and associated rectifiers are contained in Indicator Unit ID-16/TPS-1A (figs. 43 and 44). Figure 45 shows a simplified block diagram of the system and figure 46 a complete block diagram.

20. OSCILLOSCOPES.

a. The PPI oscilloscope (fig. 47) is of the magnetic type. The centering and focusing of the electron beam is controlled by three coils in the tube mounting. Potentiometer 288-1 adjusts the voltage on the horizontal centering coil, potentiometer 288-2 controls the voltage on the vertical centering coil, and potentiometer 299 controls the voltage on the focusing coil. The intensity is controlled by potentiom-

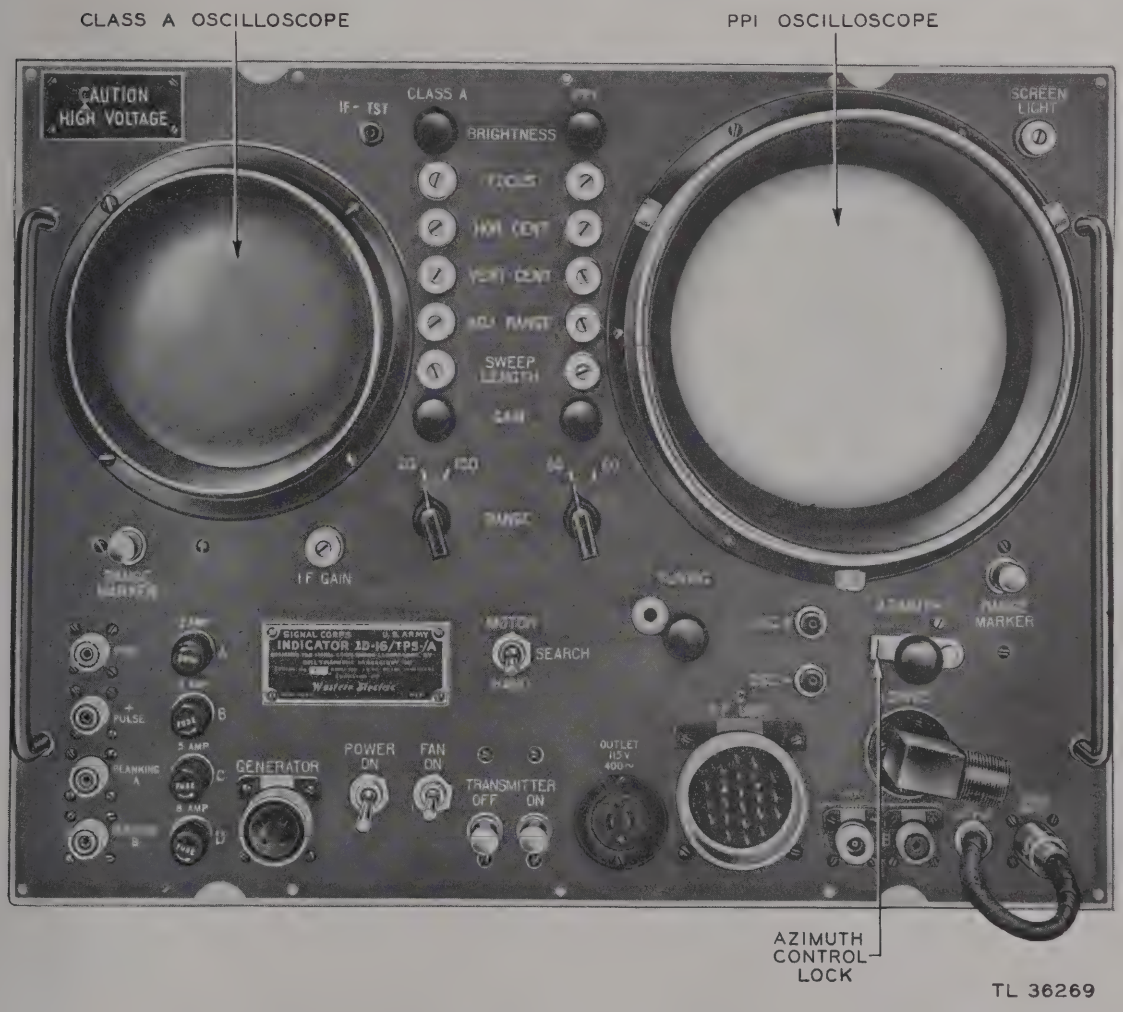

Figure 44. Indicator Unit ID-16/TPS-1A, front panel.

eter 292. The accelerator is supplied with +5,000 volts produced by a rectifier in the indicator unit. The signals are applied to deflecting coils rotated around the tube by a flexible shaft drive from the handwheel gearbox.

b. The Class A oscilloscope (fig. 47) is of the electrostatic type. Potentiometer 291-2 controls the potential of the vertical centering plates, potentiometer 293 (mounted on the Class A insulator assembly, figure 104) controls the focusing of the electron beam, and potentiometer 290 (mounted on Class A insulator assembly) controls the intensity of the electron beam. The horizontal centering is adjusted by potentiometer 287 which controls the grid bias of sweep amplifier tube 352-6. The accelerator is supplied with +1,500 volts by the same rectifier in the indicator unit which supplies +5,000 volts for the PPI tube. The signals are applied to deflecting plates which move the beam vertically.

21. SWEEP CIRCUITS.

a. General. The sweep circuits, when triggered by the positive pulse from the r-f unit, generate voltages increasing at a constant rate for moving the electron beams across the screens of the oscilloscopes. The PPI sweep circuit generates a voltage which, when applied to the deflecting coils of the PPI oscilloscope, causes the luminous spot on the oscilloscope screen to move from the center of the screen to the edge in 216 microseconds (rep-

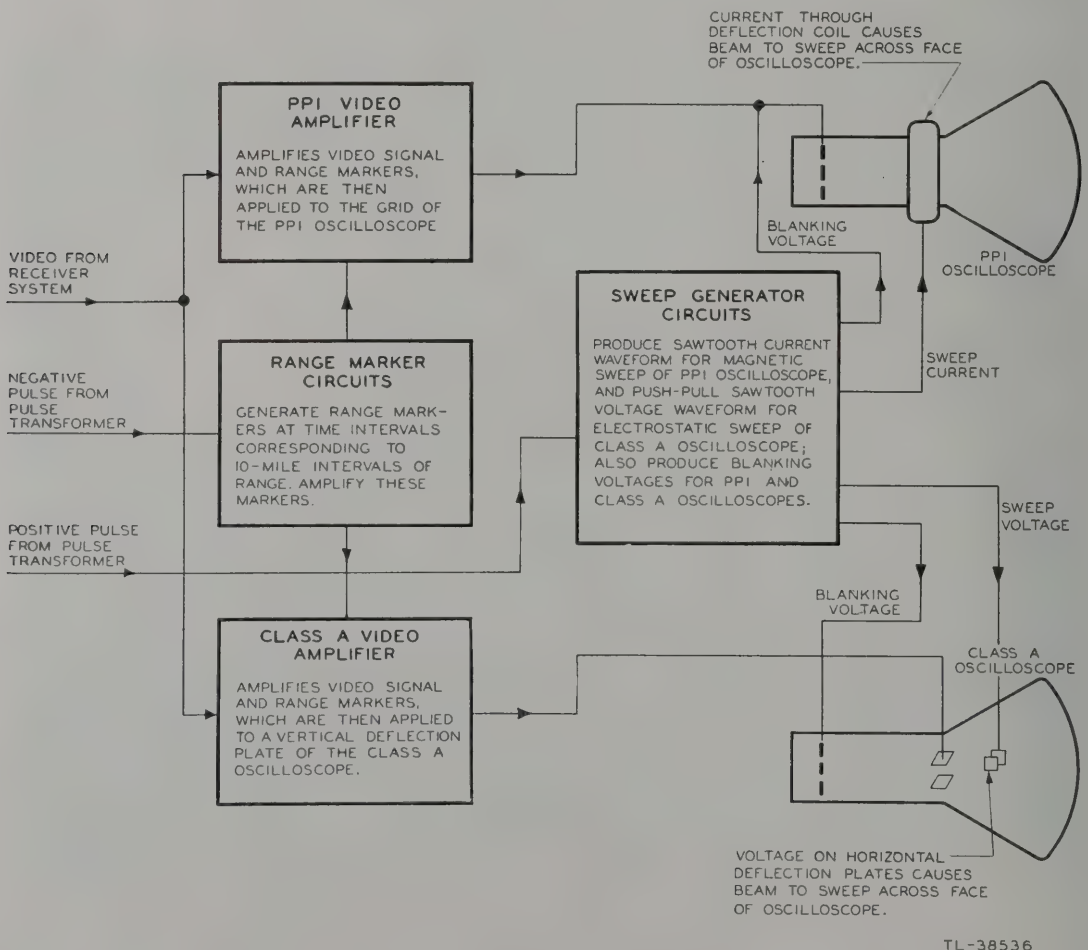
CURRENT THROUGH DEFLECTION COIL CAUSES BEAM TO SWEEP ACROSS FACE OF OSCILLOSCOPE.
PPI VIDEO AMPLIFIER
AMPLIFIES VIDEO SIGNAL AND RANGE MARKERS, WHICH ARE THEN APPLIED TO THE GRID OF THE PPI OSCILLOSCOPE
BLANKING VOLTAGE
PPI OSCILLOSCOPE
VIDEO FROM RECEIVER SYSTEM
SWEEP GENERATOR CIRCUITS
PRODUCE SAWTOOTH CURRENT WAVEFORM FOR MAGNETIC SWEEP OF PPI OSCILLOSCOPE, AND PUSH-PULL SAWTOOTH VOLTAGE WAVEFORM FOR ELECTROSTATIC SWEEP OF CLASS A OSCILLOSCOPE; ALSO PRODUCE BLANKING VOLTAGES FOR PPI AND CLASS A OSCILLOSCOPES.
SWEEP CURRENT
RANGE MARKER CIRCUITS
GENERATE RANGE MARKERS AT TIME INTERVALS CORRESPONDING TO 10-MILE INTERVALS OF RANGE. AMPLIFY THESE MARKERS.
NEGATIVE PULSE FROM PULSE TRANSFORMER
SWEEP VOLTAGE
POSITIVE PULSE FROM PULSE TRANSFORMER
BLANKING VOLTAGE
CLASS A VIDEO AMPLIFIER
AMPLIFIES VIDEO SIGNAL AND RANGE MARKERS, WHICH ARE THEN APPLIED TO A VERTICAL DEFLECTION PLATE OF THE CLASS A OSCILLOSCOPE.
CLASS A OSCILLOSCOPE
VOLTAGE ON HORIZONTAL DEFLECTION PLATES CAUSES BEAM TO SWEEP ACROSS FACE OF OSCILLOSCOPE.
TL-38536

Figure 45. Indicator system, simplified block diagram.

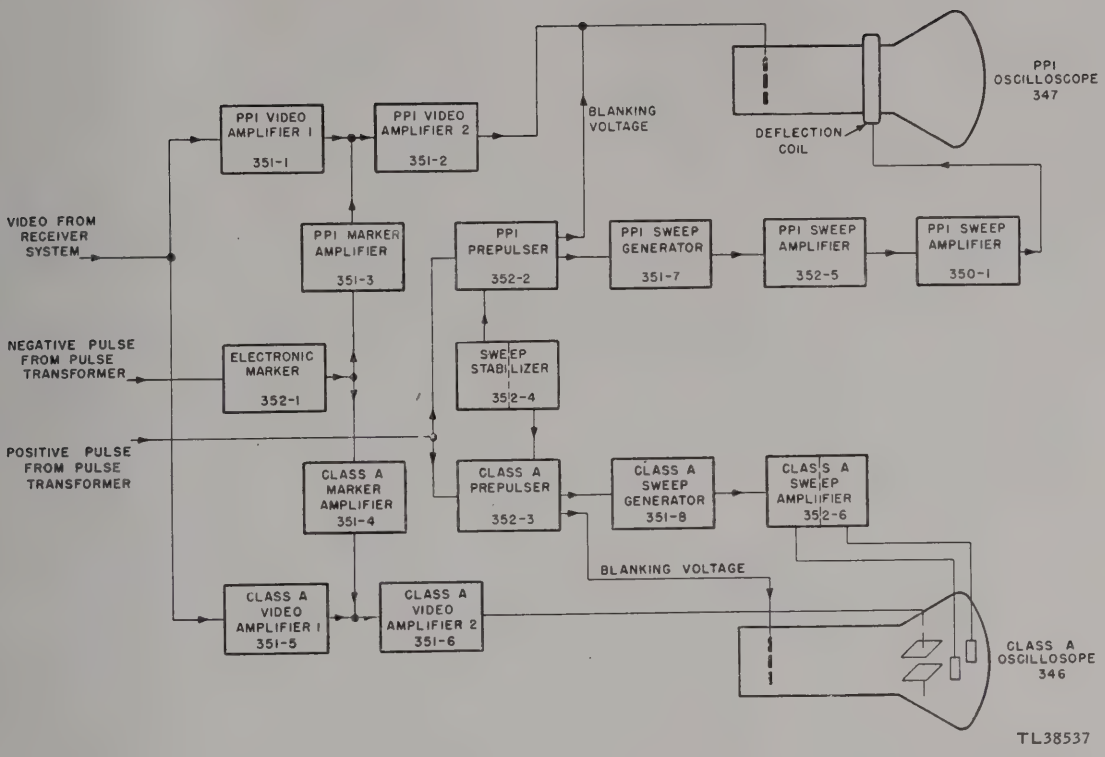

Figure 46. Indicator system, complete block diagram.

resenting 20-mile range) or 648 microseconds (representing 60-mile range) depending upon the position of the PPI RANGE switch on the indicator unit. The Class A sweep circuits generate a voltage which, applied to the horizontal deflecting plates of the Class A oscilloscope, causes the luminous spot on the oscilloscope screen to move from left to right in 216 microseconds (representing 20-mile range) or 1,080 microseconds (representing 100-mile range), depending upon the position of the CLASS A RANGE switch on the indicator unit. When the voltages from the sweep circuits cease, the electron beams return to their starting points. During the outward sweep of the beams, the sweep circuits make the intensity grids of the oscilloscopes more positive than during the return period, allowing signals received during the outward sweeps to be recorded, but blanking out signals received during the return. Location of sweep-circuit tubes is shown in figures 48 and 49.

b. Prepulsers. Each sweep circuit comprises a prepulser, a sweep generator, and a sweep amplifier. A schematic diagram of the prepulser circuits is shown in figure 50. The prepulser (352-3) acts as an electronic switch to start the sweep on the Class A oscilloscope in synchronism with the trigger pulse from the pulse transformer in the r-f unit. The pulse of about 40 volts and 2 microseconds duration is received about every 2,500 microseconds. Grid 1 of the prepulser (352-3) is held at about 70 volts above ground by the sweep stabilizer (352-4) so that the second section of the prepulser is normally conducting, passing about 2.6 milliamperes and setting the potential of both cathodes at about +70 volts. The output of this section provides the blanking voltage to the intensity grid of the oscilloscope. Since grid 4 is maintained at about +45 volts, the first section is not conducting. When the trigger pulse is received on grid 4, current starts to flow in the first section and the resulting negative voltage applied to grid 1 through the blocking capacitor (326 or 317-4, depending upon the position of the RANGE switch) causes a rapid transfer of current from plate 2 to plate 5 in a fraction of a microsecond. Grid 1 is driven

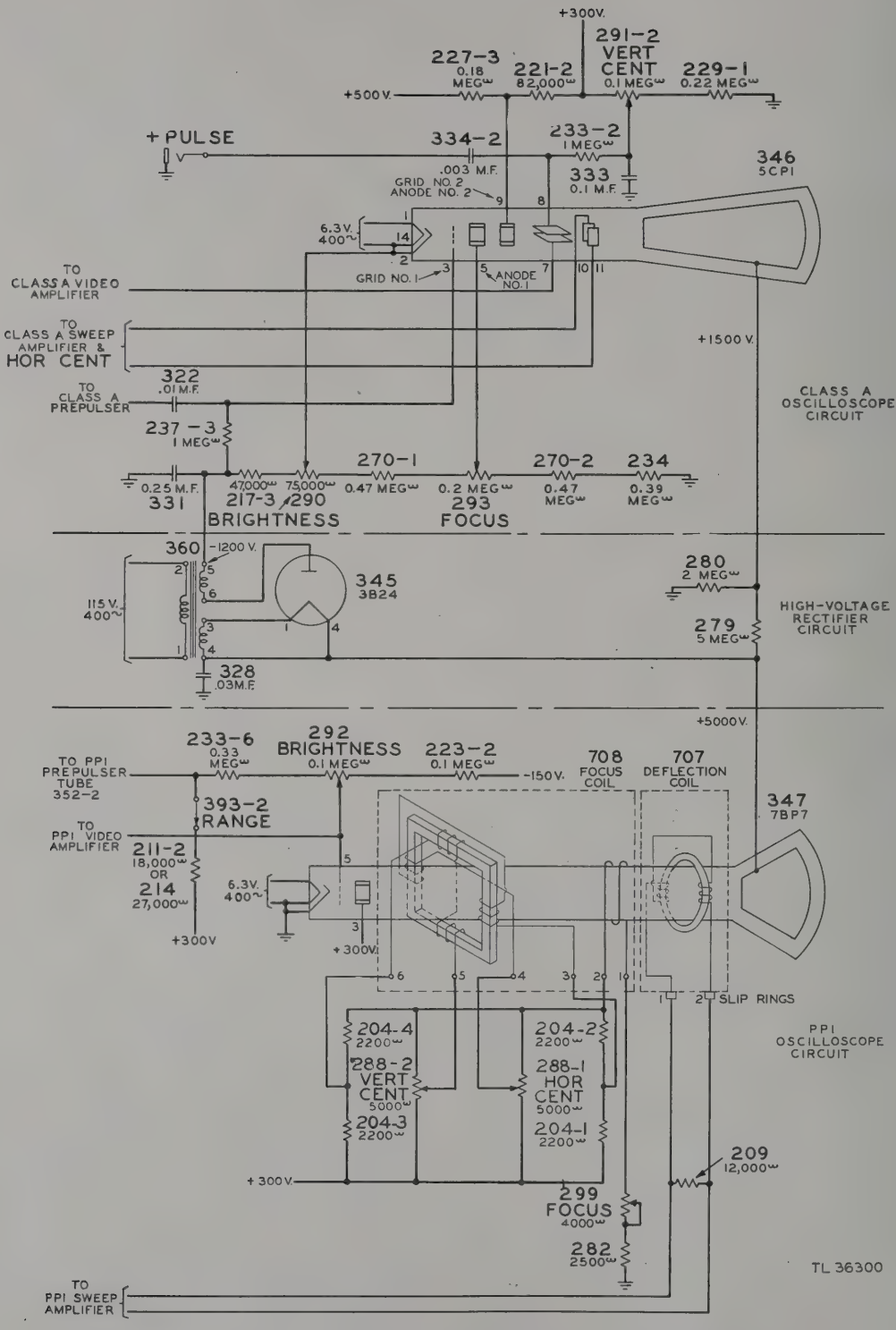

Figure 47. Class A and PPI oscilloscope circuits, simplified block diagram.

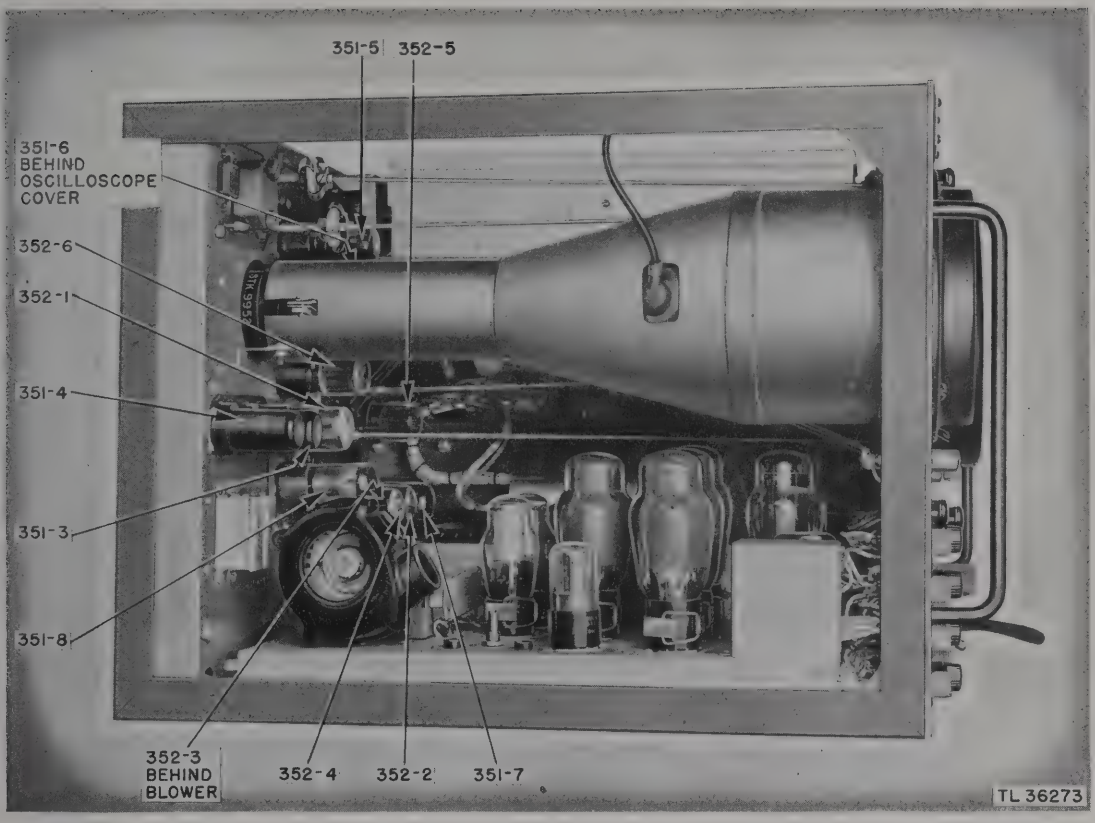

Figure 48. Indicator Unit ID-16/TPS-1A, left side view of chassis.

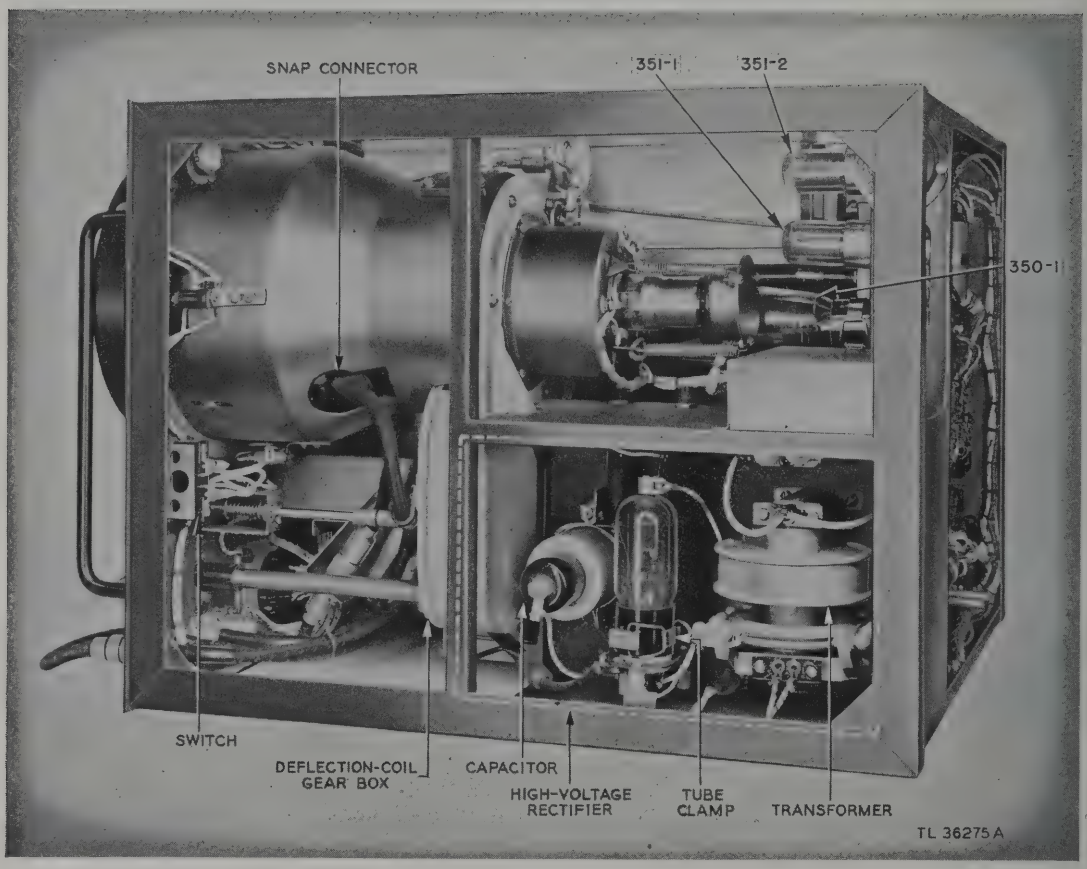

Figure 49. Indicator Unit ID-16/TPS-1A, right side view of chassis with cover of high-voltage rectifier compartment removed.

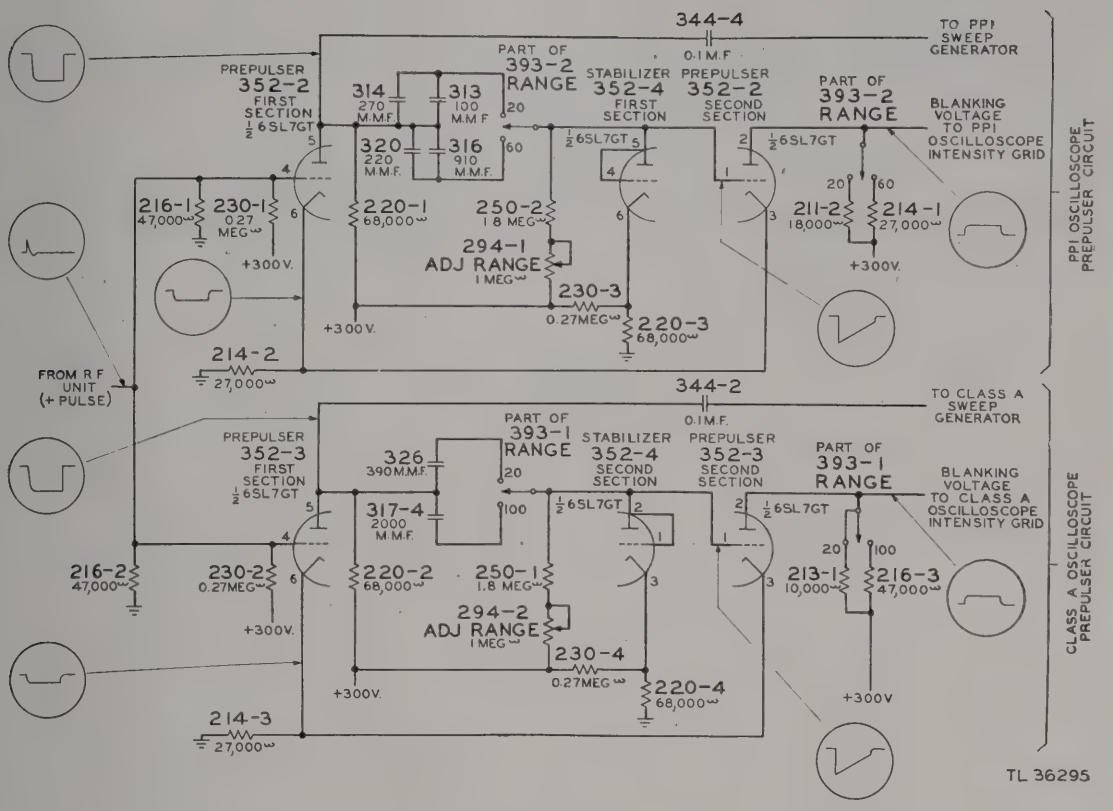

Figure 50. Class A and PPI prepulser circuits, simplified schematic diagram.

about 90 volts below cut-off. Cutting off the output of the second section increases the potential at plate 2 of this section, allowing the intensity grid of the oscilloscope to become more positive and signals to be recorded on the oscilloscope. The RANGE switch substitutes resistor 216-3 for resistor 213-1 on the 100-mile range to keep the intensity approximately the same on the two ranges. The circuit remains in this condition with the first section of the prepulser conducting and the second section cut off until grid 1 reaches about 45 volts due to charging of the blocking capacitor (326 or 317-4) through resistors 240-3 and 294-2, at which time the second section of the prepulser starts conducting again and the first section is cut off. The length of this period (and, therefore, the time during which the sweep voltage exists) is determined by the time constant of the circuit composed of capacitor 326 or 317-1 and resistors 240-3 and 294-2. The time constant may be adjusted by the ADJ RANGE potentiometer (294-2). The action is repeated when the next pulse is received. The waveforms produced in the prepulser circuit are shown in figure 51. The prepulser circuit for the PPI oscilloscope is similar to that for the Class A oscilloscope, differing only in capacity values to care for differing ranges and in resistances values for the blanking voltage.

c. Sweep Stabilizer. The sweep stabilizer 352-4 (fig. 59), one half of which serves the Class A prepulser circuit and the other half of which serves the PPI prepulser, stabilizes the grid bias voltage on the second sections of the prepulser tubes.

d. Sweep Generators. (1) In the Class A sweep generator circuit (fig. 52) tube 351-8 normally has zero grid bias and plate current flows through potentiometer 295 and resistor 242-2. Under this condition the voltage from plate 8 to cathode 5 is about 2 volts. When the negative voltage wave is received from the pre-

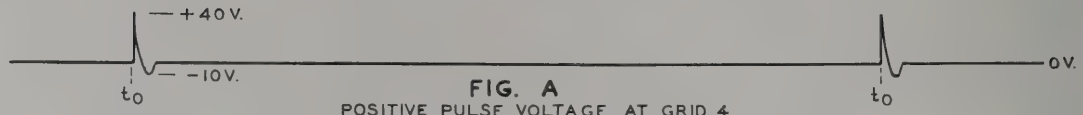

FIG. A
POSITIVE PULSE VOLTAGE AT GRID 4
OF PREPULSER TUBE 352-3

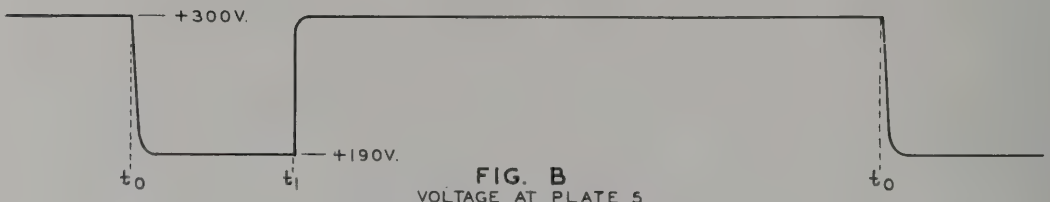

FIG. B
VOLTAGE AT PLATE 5
OF PREPULSER TUBE 352-3

FIG. C
BLANKING VOLTAGE AT PLATE 2
OF PREPULSER TUBE 352-3

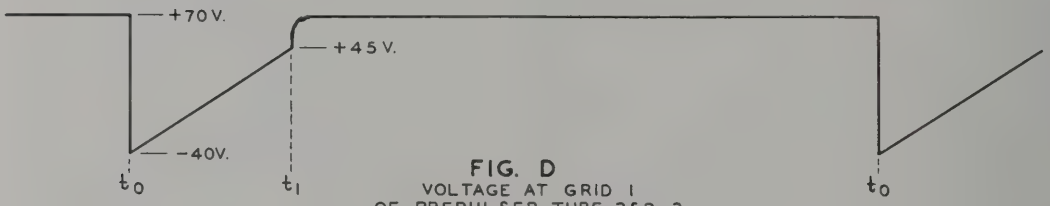

FIG. D
VOLTAGE AT GRID 1
OF PREPULSER TUBE 352-3

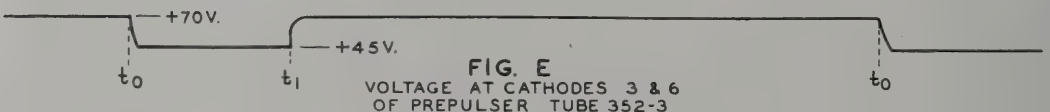

FIG. E
VOLTAGE AT CATHODES 3 & 6
OF PREPULSER TUBE 352-3

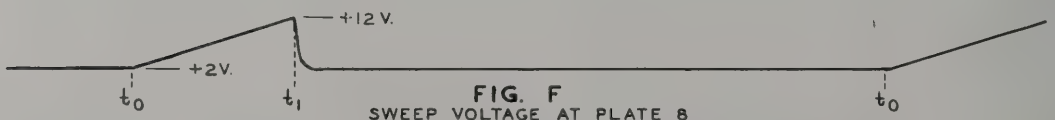

FIG. F
SWEEP VOLTAGE AT PLATE 8
OF SWEEP GENERATOR TUBE 351-8

INTERVAL	$t_0 - t_0$	ABOUT	2500	MICROSECONDS	
INTERVAL	$t_0 - t_1$	ABOUT	216	MICROSECONDS	FOR 20 MILE RANGE
INTERVAL	$t_0 - t_1$	ABOUT	648	MICROSECONDS	FOR 60 MILE RANGE
INTERVAL	$t_0 - t_1$	ABOUT	1080	MICROSECONDS	FOR 100 MILE RANGE

TL 36302

Figure 51. Sweep circuit waveforms.

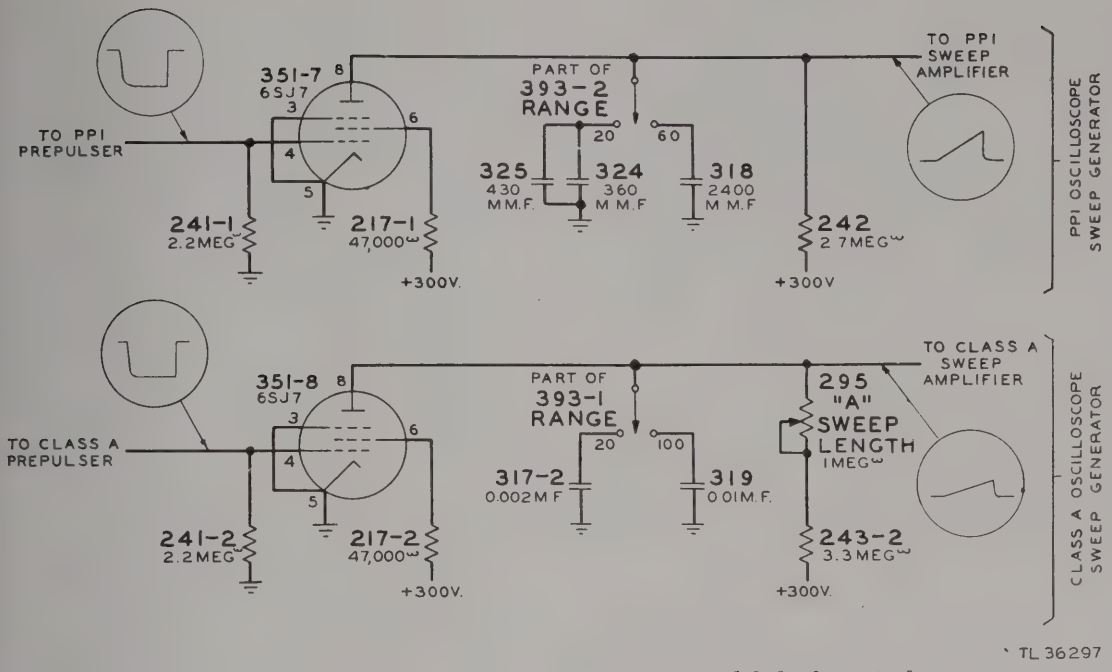

Figure 52. Class A and PPI sweep generator circuits, simplified schematic diagram.

pulser circuit, the tube is cut off and capacitor 317-2 or 319 (depending upon the position of the RANGE switch) charges through potentiometer 295 and resistor 242-2, producing a sweep voltage which rises at a substantially uniform rate to 9-12 volts. The sizes of capacitors 317-2 and 319 are such that the voltage rises to approximately the same value on both ranges. The maximum voltage attained during the sweep time (and, therefore, the length of sweep displayed on the oscilloscope) may be adjusted by potentiometer 295.

(2) The PPI sweep generator (fig. 52) is similar to the Class A sweep generator, the values of capacitors 324, 325, and 318 being different to suit the different size of oscilloscope and different ranges. The maximum voltage developed is about 24 volts. No potentiometer similar to 295 is provided since the sweep length on the PPI oscilloscope is adjusted by varying the gain of the PPI sweep amplifier.

e. Sweep Amplifiers. (1) The sweep amplifiers amplify the sweep voltages to values suitable for the two oscilloscopes. The two amplifiers are not similar because of the different characteristics of the two oscilloscopes.

(2) In the Class A sweep amplifier circuit shown in figure 53, tube 352-6 is used as a cathode phase-inverter amplifier. As the sweep voltage applied to grid 4 increases, the voltage at plate 5 decreases, but the voltages at cathodes 6 and 3 increase. The voltage at plate 2 is 180 degrees out of phase with that at plate 5 because grid 1 is held at a fixed potential while the input is applied to cathode 3. With increasing cathode potential the current through the second section of the tube decreases and the voltage at plate 2 increases. The decreasing voltage at plate 5 and the increasing voltage at plate 2 are taken to the two horizontal deflecting plates of the Class A oscilloscope and cause the beam of that oscilloscope to deflect during the sweep time. The potential on grid 1 may be adjusted by potentiometer 287 (HOR CENT) which changes the voltages at plates 5 and 2, thus changing the horizontal position of the trace on the oscilloscope.

(3) The PPI sweep amplifier (fig. 54) is a three-stage, resistance-capacitance coupled amplifier using the two sections of tube 352-5 for the first two stages, and tube 350-1 as the output stage which energizes the deflection coils of the PPI oscilloscope. Feedback exceeding 40 decibels from the cathode of tube 350-1 to the cathode of the first section of tube 352-5 insures stability of performance. The length of sweep line on the oscilloscope is adjusted by

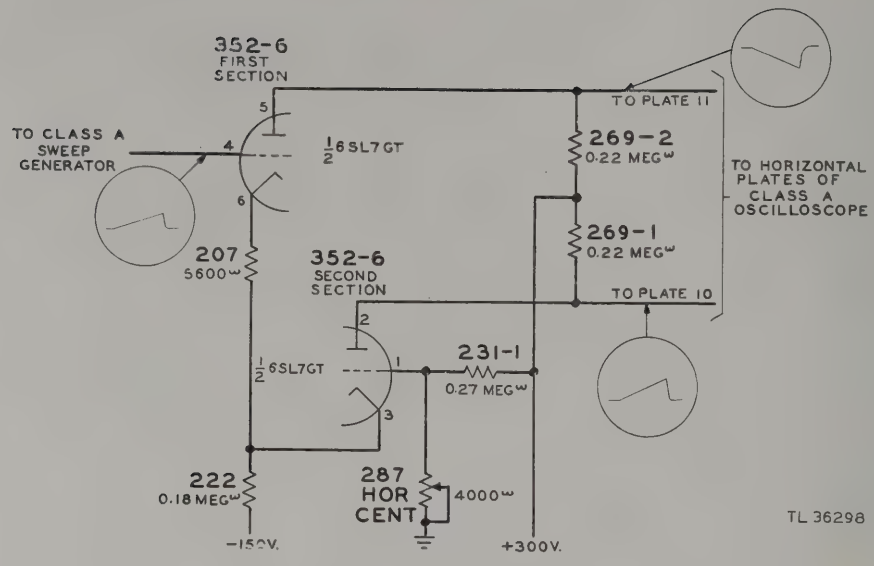

Figure 53. Class A sweep amplifier circuit, simplified schematic diagram.

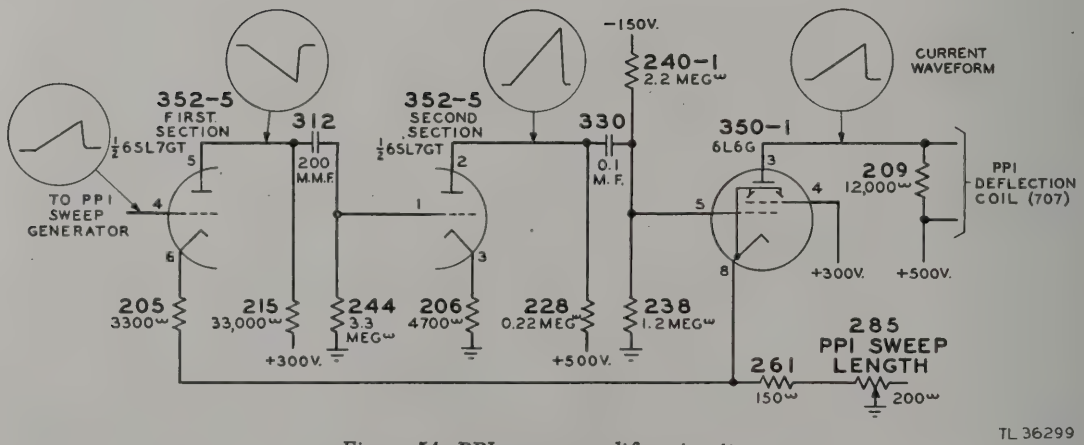

Figure 54. PPI sweep amplifier circuit, simplified schematic diagram.

varying the amount of feedback and the gain of the amplifier by means of potentiometer 285 (PPI SWEEP LENGTH). After the termination of the sweep, the coupling capacitors discharge and produce a negative output that, if provision is not made to prevent it, would cause the spot on the oscilloscope to go on past the center of the screen when it returns. This is prevented by bias on the grid of tube 350-1 provided by —150 volts through resistors 240-1 and 238. This bias is sufficient to reduce the plate current to zero when the input reaches zero or goes negative, and to allow for some variation in the —150-volt supply. The slight delay in starting the sweep which results from this allowance is not significant even on the shortest range used.

22. RANGE MARKER GENERATOR AND AMPLIFIERS.

See figure 48 for location of range marker generator and amplifier tubes.

a. The range marker generator produces a series of pulses starting with the modulator pulse and spaced 108 microseconds apart (equivalent to 10 miles). These pulses when amplified and applied to the oscilloscopes produce the range markers on the oscilloscopes.

b. The circuit, shown in simplified form in figure 55, comprises a multivibrator 352-1 and two amplifiers, 351-3 for the PPI oscilloscope and 351-4 for the Class A oscilloscope.

c. The first section of tube 352-1 is normally conducting and plate current from that section establishes the grid potential of the second section at about 130 volts. When a pulse is received on grid 4 from the r-f unit, the first section is cut off and cathode capacitor 341 charges in about 2 microseconds to a potential of about 153 volts. The second section is therefore cut off. The capacitor gradually discharges through resistor 243 until the cathode potential falls to about 133 volts. Then plate current begins to flow in the second section of tube 352-1 and, due to the positive feedback, the first section is quickly cut off so that its plate potential rises to about 150 volts. Current then flows in the second section, charging capacitor 341 and the action is repeated. The repetition continues indefinitely but is retimed each time a pulse is received from the r-f unit. Each time the plate potential of the second section rises, it produces a marker pulse which is transmitted through capacitor 327-4 to the marker amplifiers. The

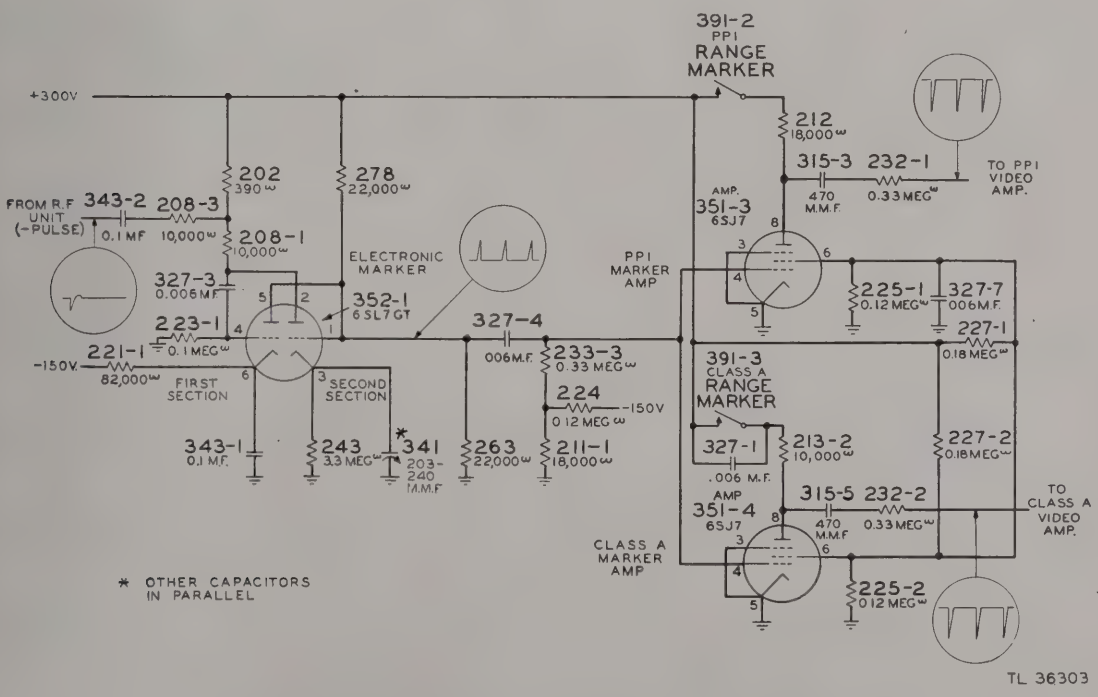

Figure 55. Range marker circuits, simplified schematic diagram.

pulses are made to occur at intervals of 108 microseconds by adjusting capacitor 341. Marker pulses are therefore produced at intervals corresponding to 10 miles and synchronized with pulses produced by the modulator.

d. The pulses are amplified for the PPI oscilloscope in tube 351-3 and for the Class A oscilloscope in tube 351-4. These tubes are operative (and range markers are displayed on the oscilloscopes) only when they are supplied with plate voltage by the closure of RANGE MARKER switches 391-2 and 391-3, which control the range marker of each oscilloscope independently.

23. VIDEO AMPLIFIERS.

A separate video amplifier is provided for each oscilloscope. The two are similar and are two-stage resistance-capacitance coupled amplifiers. The circuits are shown in figure 56. See figures 48 and 49 for location of tubes. The video signal from the detector of the i-f amplifier assembly is applied to the grids of tubes 351-1 and 351-5 through GAIN potentiometers 286-1 and 286-2 which permit the gain of each amplifier to be adjusted separately. The output tubes can deliver about 100 volts maximum. Applied to the deflecting plates of the Class A oscilloscope, this produces a deflection of about 2 inches. The voltage is higher than required for the PPI oscilloscope and is reduced on the PPI amplifier by capacitors 311 and 310 with resistor 236-1 so that the gain on this amplifier does not have to be set low.

24. RECTIFIERS.

a. Three rectifiers for providing the necessary d-c voltages are contained in the indicator unit and are shown schematically in figure 57. Rectifier tubes 348-1 and 348-2 (fig. 58) supplied by transformer 362 constitute a full-wave rectifier producing +500 volts direct current. The filter composed of inductor 367 and capacitors 339-1 and 339-2 reduces radio interference. The drop across resistor 271 produces

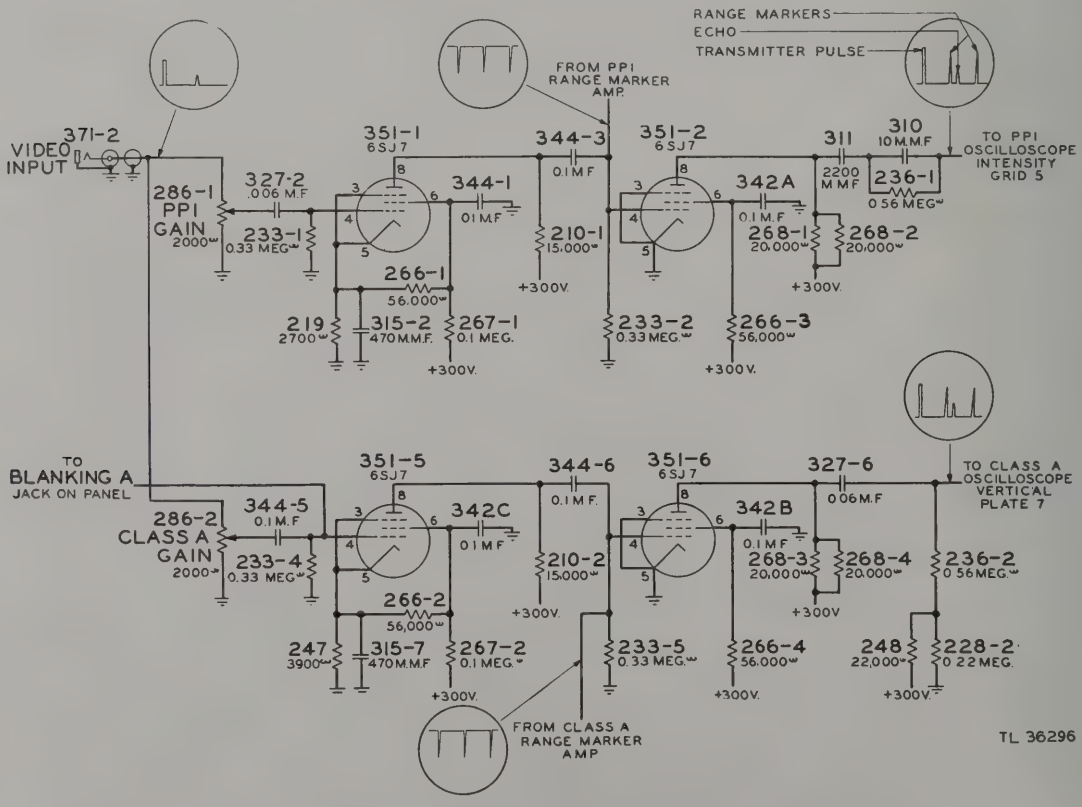

Figure 56. Video amplifier circuits, simplified schematic diagram.

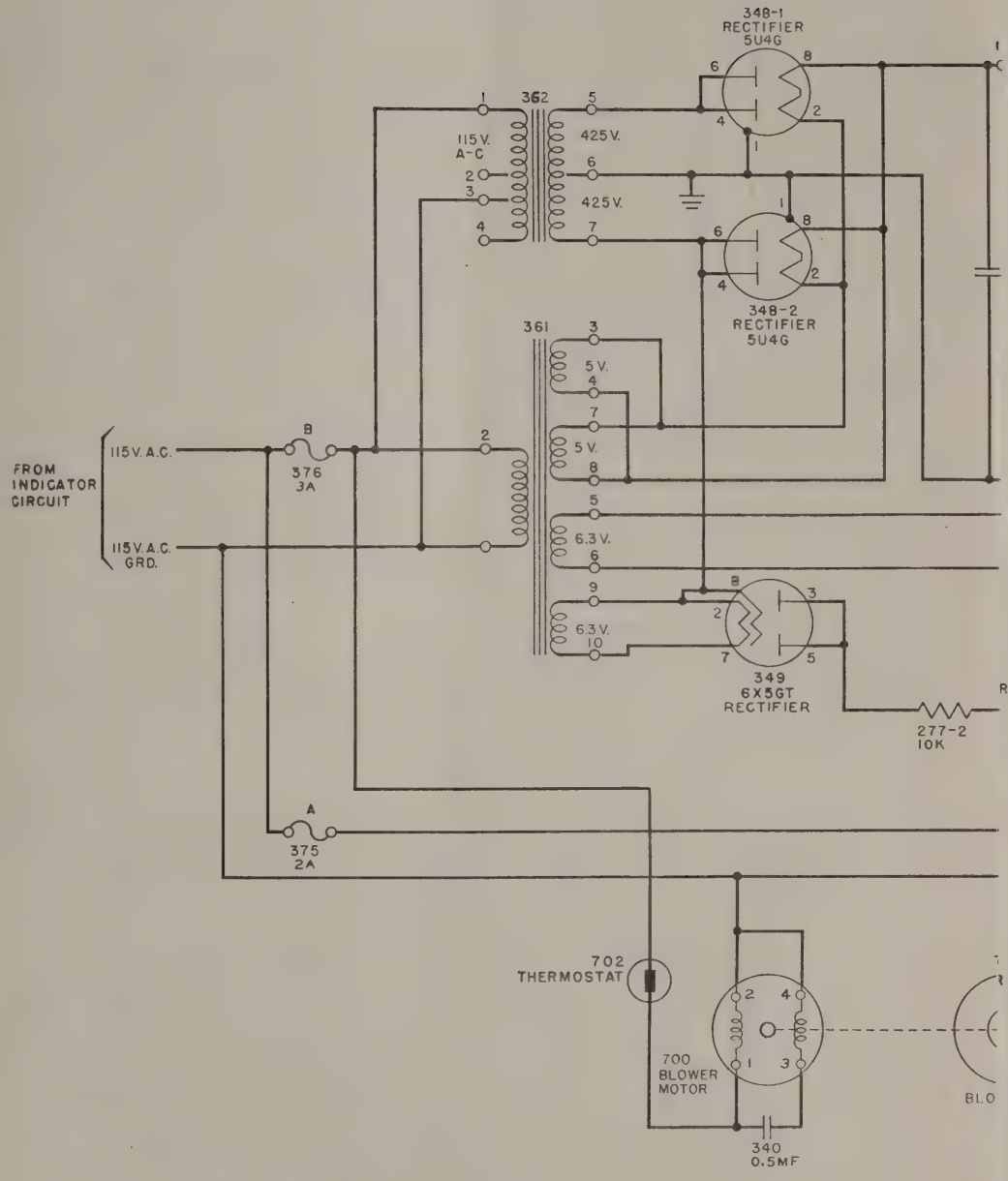

Figure 57. Indicator Unit ID-16/TPS-1A, rectifier circuits, complete schematic diagram.

pulses are made to occur at intervals of 108 microseconds by adjusting capacitor 341. Marker pulses are therefore produced at intervals corresponding to 10 miles and synchronized with pulses produced by the modulator.

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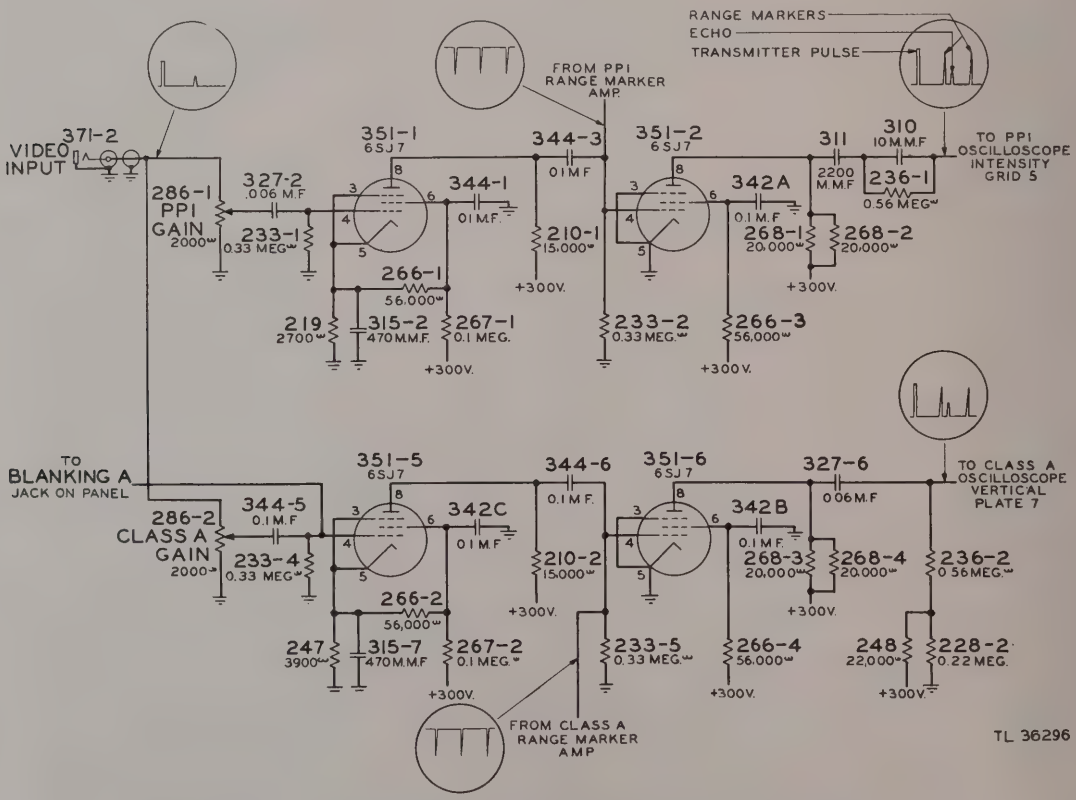


Figure 56. Video amplifier circuits, simplified schematic diagram.

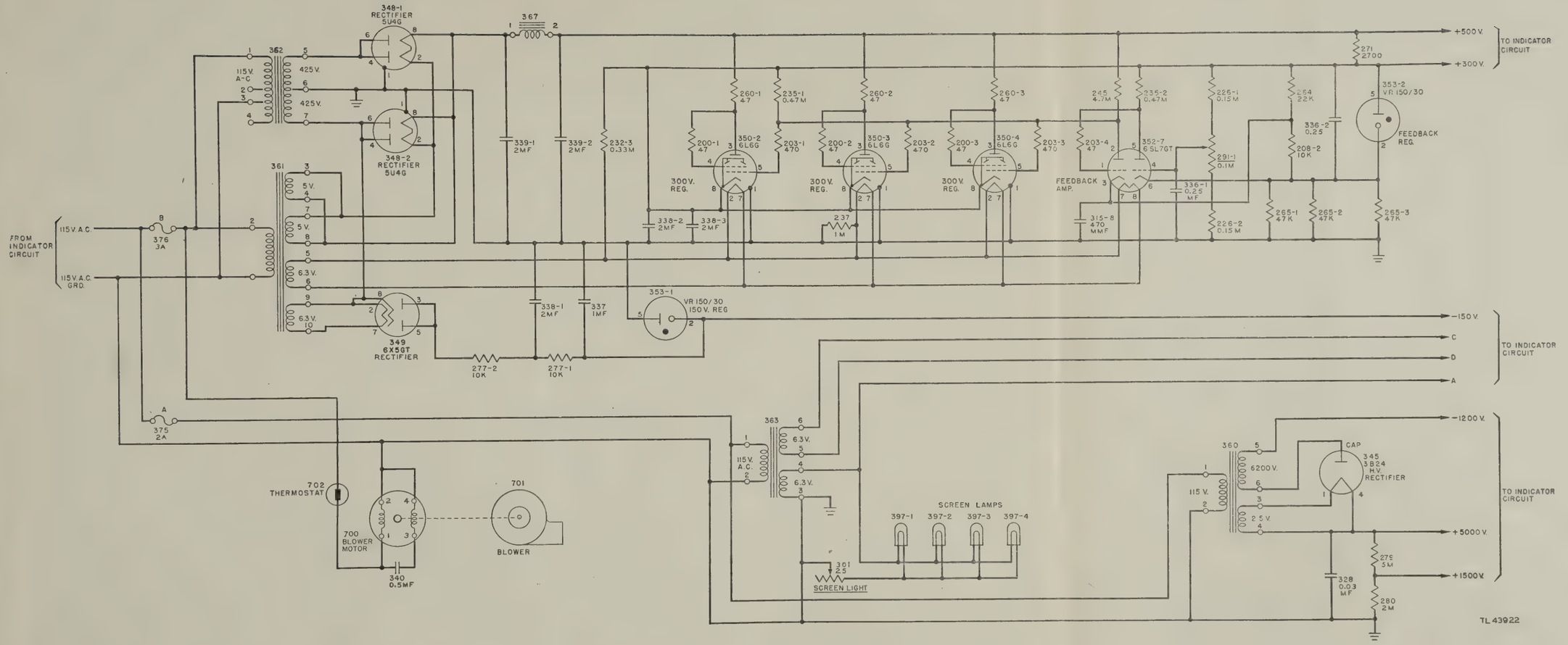
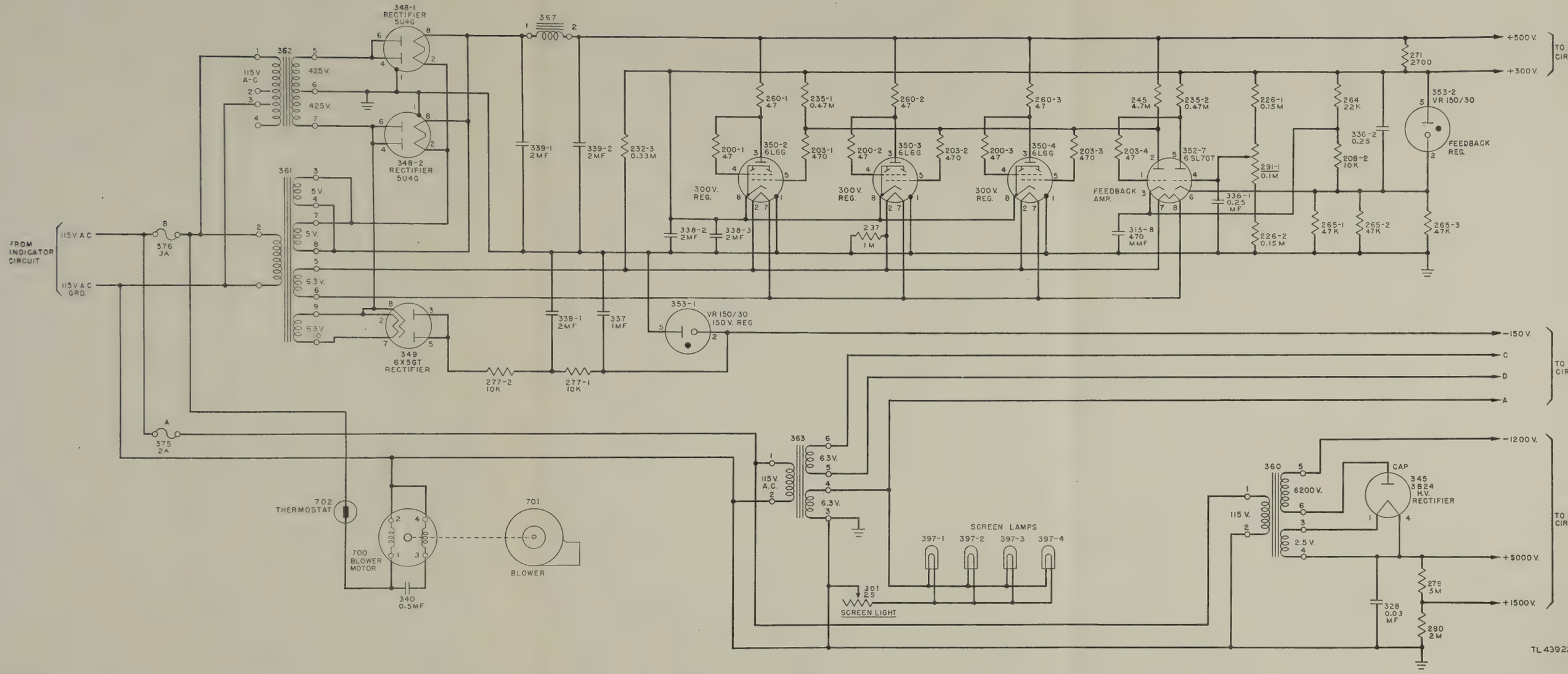


Figure 57. Indicator Unit ID-16/TPS-1A, rectifier circuits, complete schematic diagram.


348-1 RECTIFIER 5U4G
367
362
115V A-C
425V.
425V.
348-2 RECTIFIER 5U4G
361
5V.
5V.
6.3V.
6.3V.
349 6X5GT RECTIFIER
339-1 2MF
339-2 2MF
232-3 0.33M
260-1 47
235-1 0.47M
200-1 47
350-2 6L6G
203-1 470
260-2 47
200-2 47
350-3 6L6G
203-2 470
260-3 47
200-3 47
350-4 6L6G
203-3 470
245 4.7M
235-2 0.47M
203-4 47
352-7 6SL7GT
226-1 0.15M
291-1 0.1M
226-2 0.15M
264 22K
208-2 10K
271 2700
353-2 VR 150/30
FEEDBACK REG.
336-2 0.25
336-1 0.25 MF
265-1 47K
265-2 47K
265-3 47K
300V. REG.
300V. REG.
300V. REG.
FEEDBACK AMP.
338-2 2MF
338-3 2MF
237 1M
315-8 470 MMF
+500V.
+300V.
TO IND CIRCU
FROM INDICATOR CIRCUIT
115V A.C
115V A.C GRD.
376 3A
375 2A
338-1 2MF
337 1MF
353-1 VR 150/30 150V. REG
277-2 10K
277-1 10K
-150V.
C
D
A
TO IN CIRCU
363
115V. A.C.
6.3V.
6.3V.
SCREEN LAMPS
397-1
397-2
397-3
397-4
301 25
SCREEN LIGHT
702 THERMOSTAT
700 BLOWER MOTOR
701
BLOWER
340 0.5MF
360
115 V.
6200V.
2.5 V.
CAP
345 3B24 H.V. RECTIFIER
-1200V.
+5000V.
+1500V.
TO IN CIRCU
279 3M
328 0.03 MF
280 2M
TL 43922

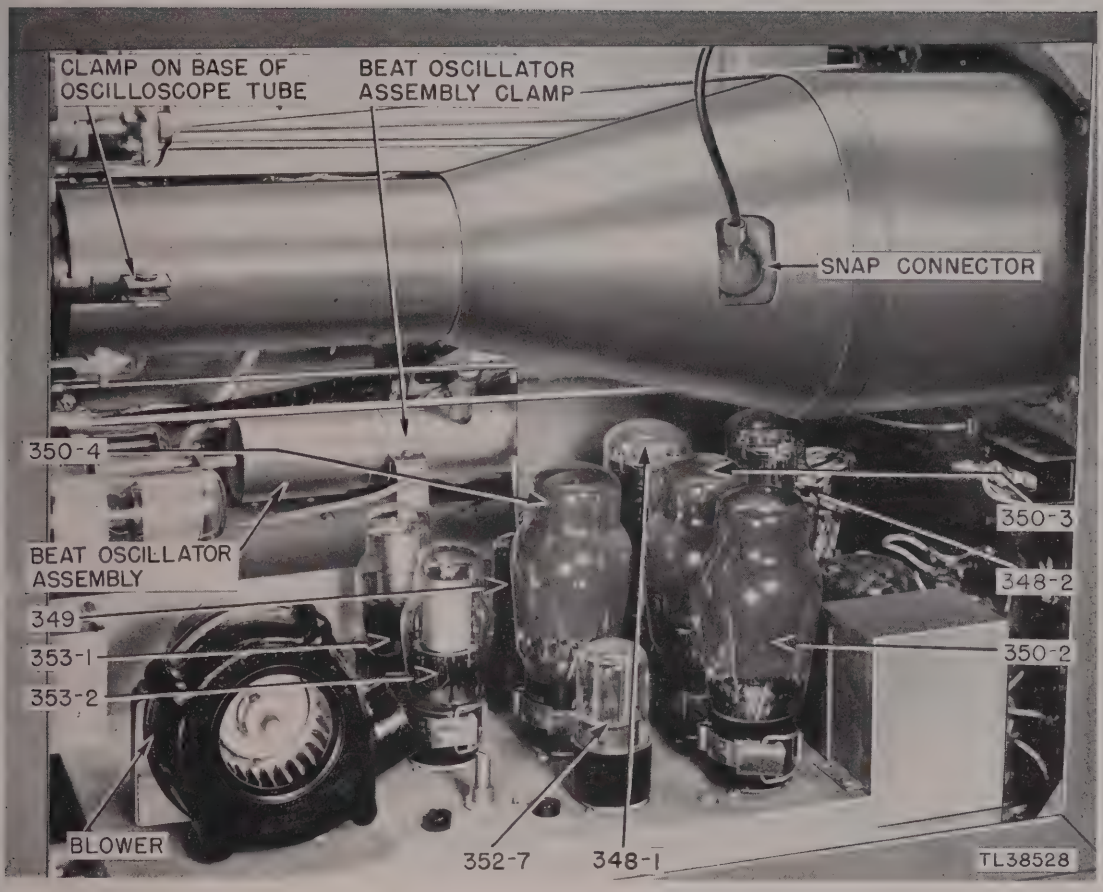


Figure 58. Indicator Unit ID-16/TPS-1A, left side.

+300 volts. The +300-volt output of the rectifier is regulated by a vacuum tube regulator composed of tubes 350-2, 350-3, 350-4, 352-7, and 353-2 (fig. 58). Gas tube 353-2 establishes a fixed voltage at cathode 6 of amplifier 352-7, while the potential at grid 4 is determined by the voltage divider composed of resistors 226-1, 291-1, and 226-2. Any variation in the +300 volts changes the potential of grid 4 and is amplified in the output of the right section of this tube. As plate 5 of this section feeds into grid 1 of the left section the change in voltage is further amplified in the left section of this tube and transmitted to the grids of series regulator tubes 350-2, 350-3, and 350-4, which are in parallel, altering their effective resistance and bringing the +300-volt output of the rectifier back to its normal value.

b. Tube 349 (fig. 58), supplied by one half of the secondary of transformer 362, is a half-wave rectifier producing —150 volts direct current. The output voltage is regulated by gas tube 353-1, which establishes a fixed potential across the output of the rectifier.

c. Transformer 359 in the high-voltage rectifier steps up the 115 volts alternating current to 6,200 volts, which is rectified by diode tube 345. (Transformer 359 is an improvement, replacing transformer 360 which is shown in figure 49.) Resistors 279 and 280, and resistors 290, 270-1, 293, 270-2, and 234 in the indicator circuit (fig. 59) are across the output of the rectifier. These resistors constitute a voltage divider from which +5,000 volts, +1,500 volts, —1,200 volts are obtained; cathode, intensity grid, and focusing voltages for the Class A oscilloscope are obtained by tapping off at different points.

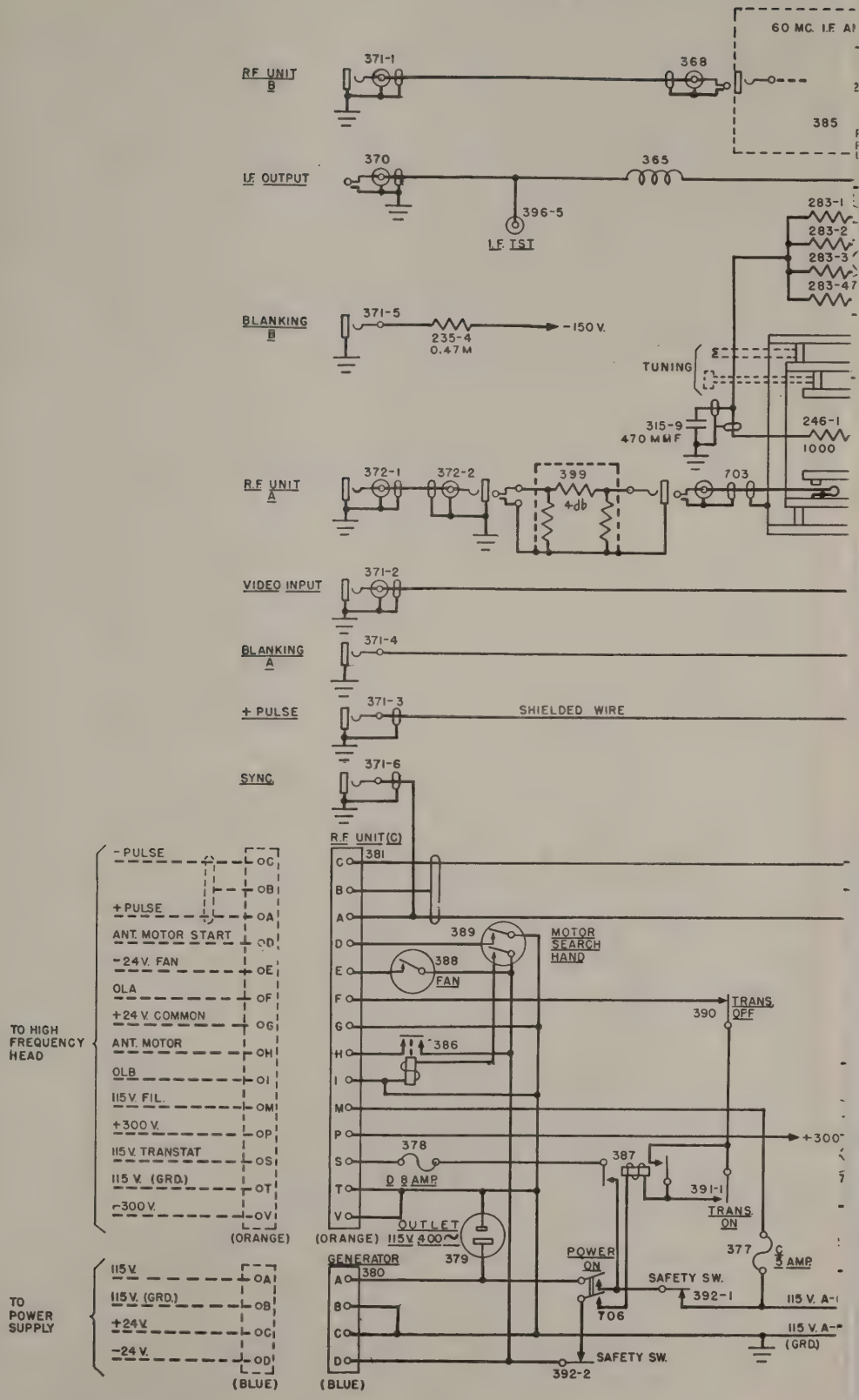
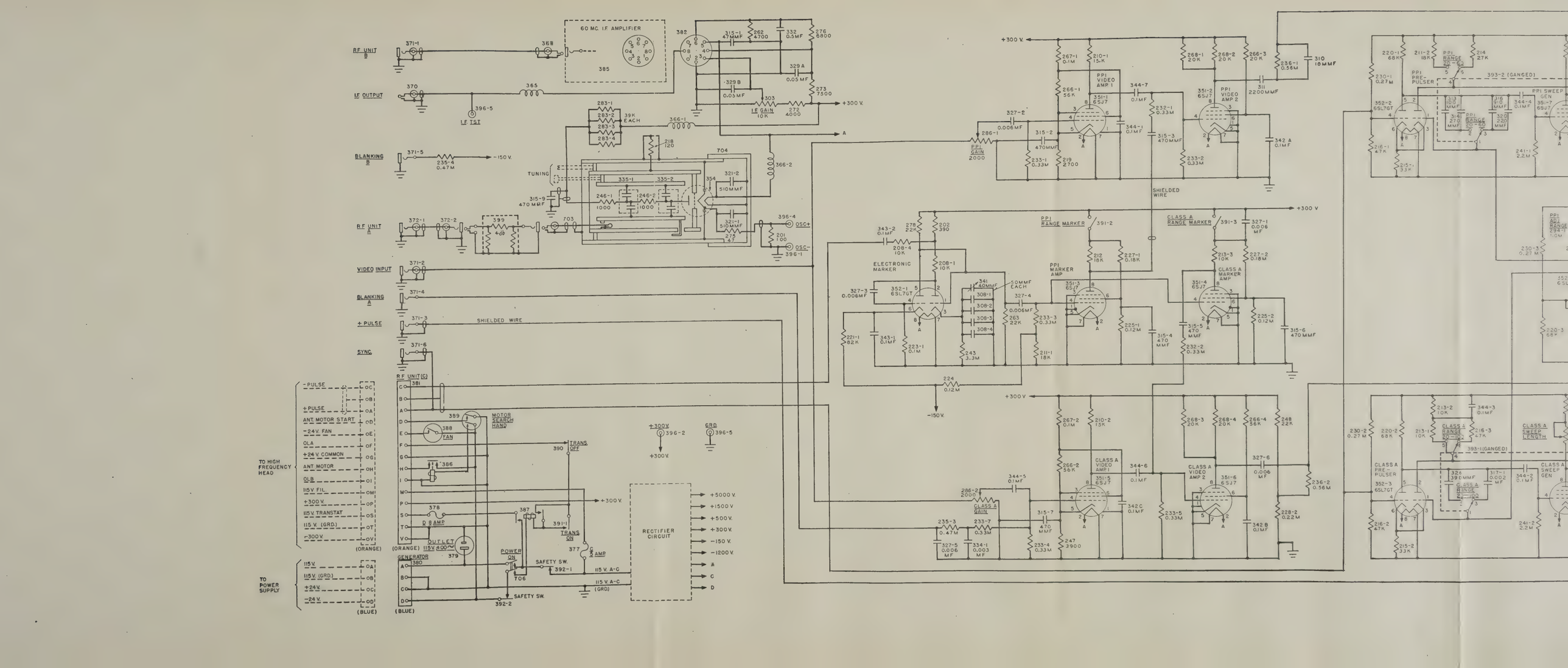


Figure 59. Indicator Unit ID-16/TPS-1A, schematic diagram complete except for rectifier circuits and i-f amplifier assembly.



60 MC. I.F. AMPLIFIER
RF UNIT B
I.F. OUTPUT
I.F. TST
BLANKING B
RF UNIT A
VIDEO INPUT
BLANKING A
+ PULSE
SYNC.
SHIELDED WIRE
TUNING
I.F. GAIN
PPI VIDEO AMP 1
PPI VIDEO AMP 2
PPI GAIN
PPI RANGE MARKER
CLASS A RANGE MARKER
ELECTRONIC MARKER
PPI MARKER AMP
CLASS A MARKER AMP
CLASS A VIDEO AMP 1
CLASS A VIDEO AMP 2
CLASS A GAIN
PPI PRE-PULSER
PPI SWEEP GEN
CLASS A PRE-PULSER
CLASS A SWEEP LENGTH
CLASS A SWEEP GEN
RF UNIT (C)
MOTOR SEARCH HAND
FAN
TRANS OFF
TRANS ON
POWER ON
SAFETY SW.
OUTLET
GENERATOR
RECTIFIER CIRCUIT
TO HIGH FREQUENCY HEAD
TO POWER SUPPLY
(ORANGE)
(BLUE)
+300 V.
-150 V.
+5000 V.
+1500 V.
+500 V.
+300 V.
-150 V.
-1200 V.

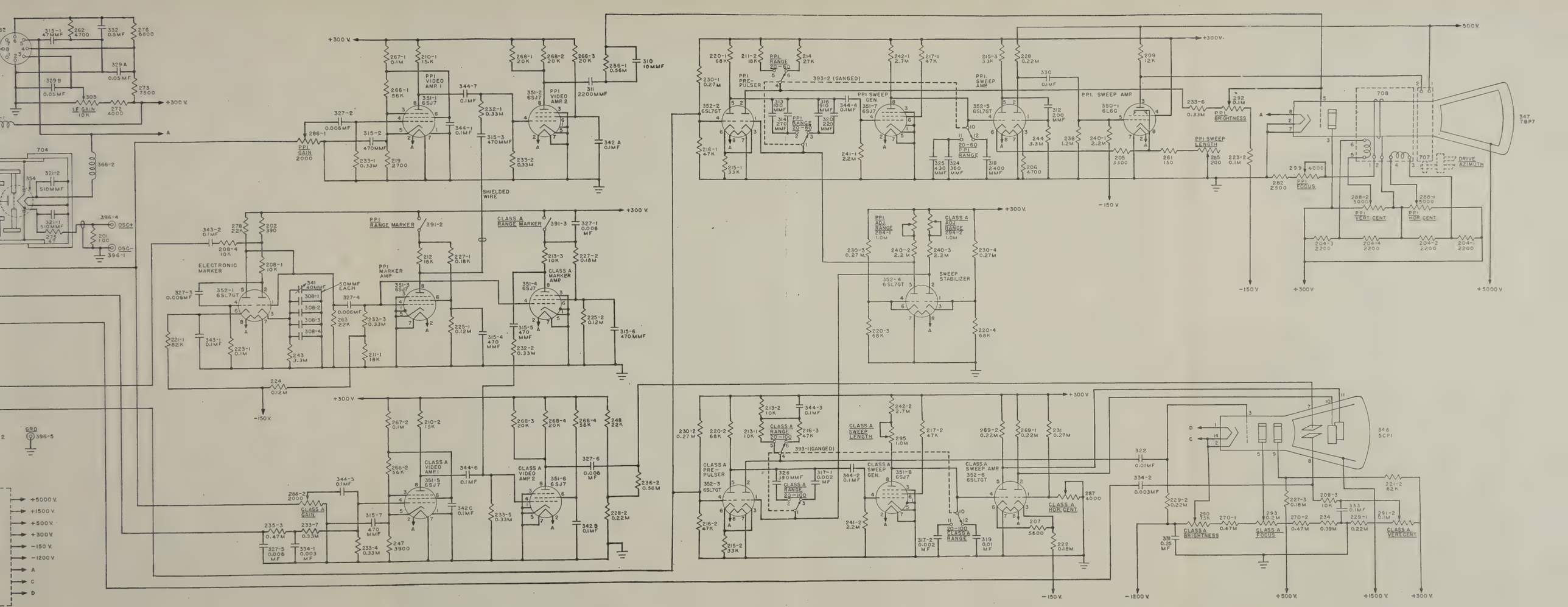


Figure 59. Indicator Unit ID-16/TPS-1A, schematic diagram complete except for rectifier circuits and i-f amplifier assembly.

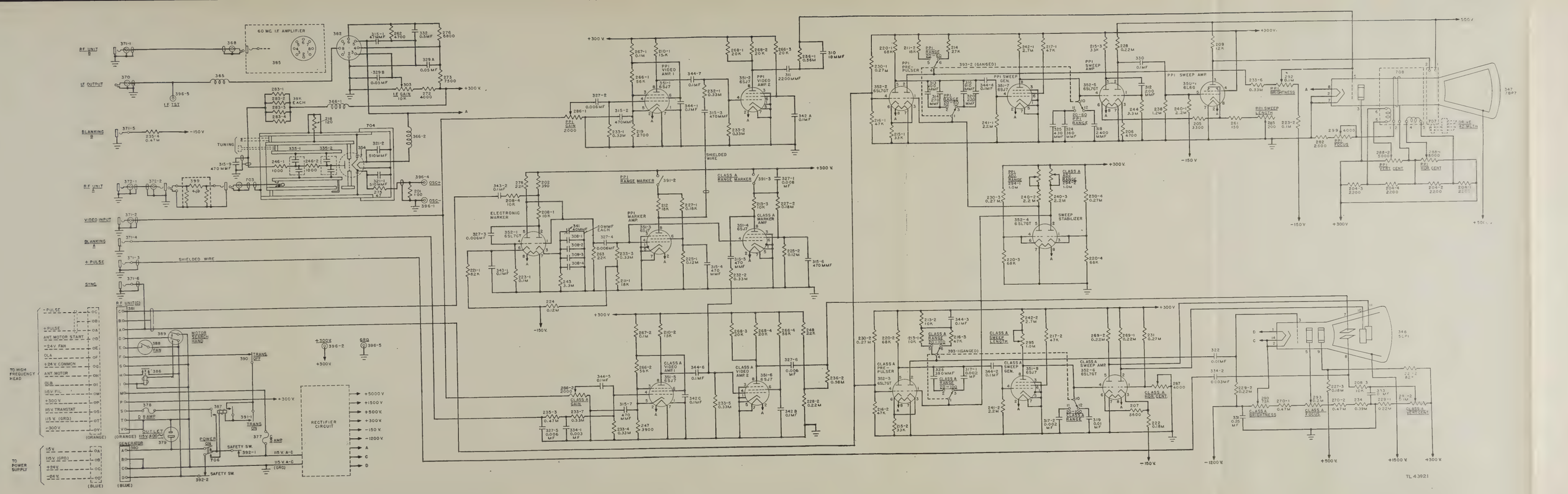


Figure 59. Indicator Unit ID-16/TPS-1A,

SECTION VII
SPECIALIZED TEST EQUIPMENT

25. INTRODUCTION.

Supplied with Radio Set AN/TPS-1A is Test Set TS-91/TPS-1 (echo box). The theory of this set is presented in this section.

26. ECHO BOX.

a. Purpose. The echo box consists of a high-Q, tunable, resonant cavity that can be loosely coupled to the transmitter output. This unit produces an artificial or phantom target echo which may be used to tune the receiver to the transmitter. The echo box may also be used to give an approximate indication of the transmitter output relative to some arbitrary standard; if accurately calibrated, it may be used to measure frequency.

b. Description of Operation. Energy from the radar transmission line is fed into the resonant cavity to make it oscillate. Since the Q is very high, the cavity oscillates or "rings" for several microseconds after the end of the transmitted pulse. During the time that the echo box is ringing, it feeds energy back into the radar transmission line which produces an echo pulse on the indicator screen. The length of time that the echo box oscillates is dependent on the tuning and losses in the cavity, the pulse shape and peak power of the transmitter, and the tuning of the r-f and receiver systems. Since the echo box can be tuned to the transmitter under a given set of operating conditions, the r-f and receiver systems may be tuned by watching for maximum width of the pulse that appears on the indicator screen. Drawings in figure 60 represent the appearance of this pulse on both the Class A and PPI oscilloscopes.

c. Characteristics. Test Set TS-91/TPS-1 (echo box) is shown in figures 61 and 62. A chart attached to the panel is reproduced in figure 69. This test set consists of a cylindrical cavity, a meter panel (fig. 63) on which is mounted a d-c microammeter and a crystal rectifier, a 10-db pad, a 12-foot plug-ended cable, and a jack-ended connector. The cavity is tuned by moving a metal plunger axially in the cylinder of the cavity. The plunger diameter is slightly less than the internal diameter of the cylinder. The plunger position is controlled by a rack and pinion and the FREQUENCY CONTROL knob. An arbitrary scale reading from 0 to 70, each division corresponding to about 1 megacycle, is provided for reference purposes. Coupling loops are used to introduce and remove energy from the echo box. These loops are polarized in a plane perpendicular to the cylinder axis in order to link the maximum lines of magnetic flux. The amount of insertion, and thus the amount of coupling by the input loop, can be controlled by the INPUT LOOP knob. The output loop is controlled by the OUTPUT LOOP knob. As one loop is used to introduce energy into the box, the second loop may be used to remove some of this enregy. If this r-f energy is rectified through a crystal detector, its comparative strength can be measured on a microammeter.

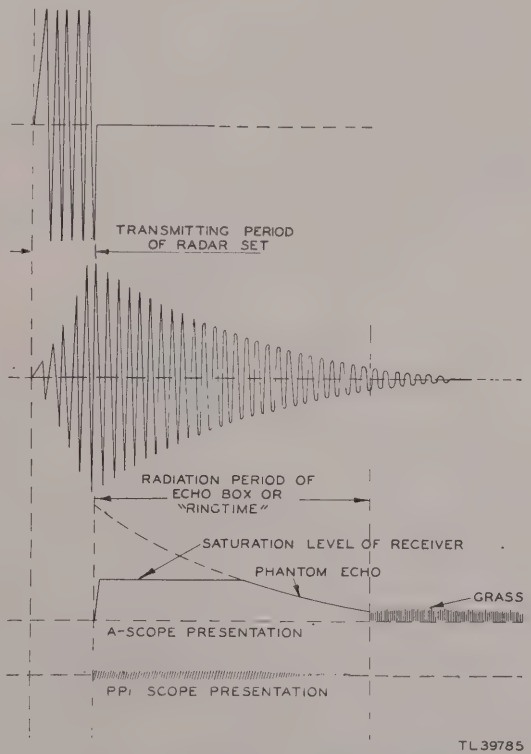


Figure 60. Echo box oscillations and oscilloscope patterns.

SECTION VII
SPECIALIZED TEST EQUIPMENT

25. INTRODUCTION.

Supplied with Radio Set AN/TPS-1A is Test Set TS-91/TPS-1 (echo box). The theory of this set is presented in this section.

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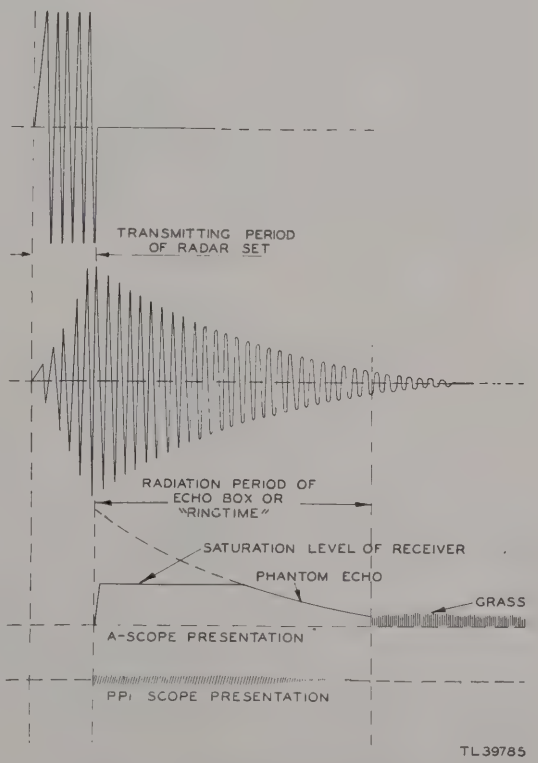


Figure 60. Echo box oscillations and oscilloscope patterns.

By this means the frequency and power output of the transmitter may be measured. The echo box is a manually-tuned resonant cavity. When used to measure frequency it actually serves as a narrow band-pass filter. The output loop is connected by means of the attached cable and OUTPUT PLUG to the METER JACK on the crystal rectifier meter, and the cavity is tuned to the unknown frequency connected to the INPUT JACK. It serves as an echo box or "artificial target" when it is tuned to the radio set transmitter frequency, and the radio set receiver is tuned to the echo box by observing the ringtime on the Class A oscilloscope.

d. Theory of Operation. (1) Electrically, the echo-box cavity is equivalent to a sharply tuned inductance-capacitance resonant circuit. It is not correct, however, to consider any particular part of the box as either the capacitance or inductance of the equivalent circuit. The frequency to which the box is resonant is dependent upon the physical size of the cavity and this size is changed by moving the plunger. When the size of the cavity is decreased, the resonant frequency is raised; when the size of the cavity is increased, the resonant frequency is lowered.

(2) In the design and construction of the resonant cavity, internal losses have been kept to a minimum. Consequently, the figure of merit, or equivalent circuit Q, is very high—about 60,000. This is in contrast to the Q of a resonant circuit using lumped inductance and capacitance, where the Q is seldom greater than 800 or 1,000, even under very favorable conditions. This fact explains why oscillations continue to build up throughout the duration of the radio-frequency pulse received from the radar, because the higher the Q of a system, the more slowly does it build up to maximum response.

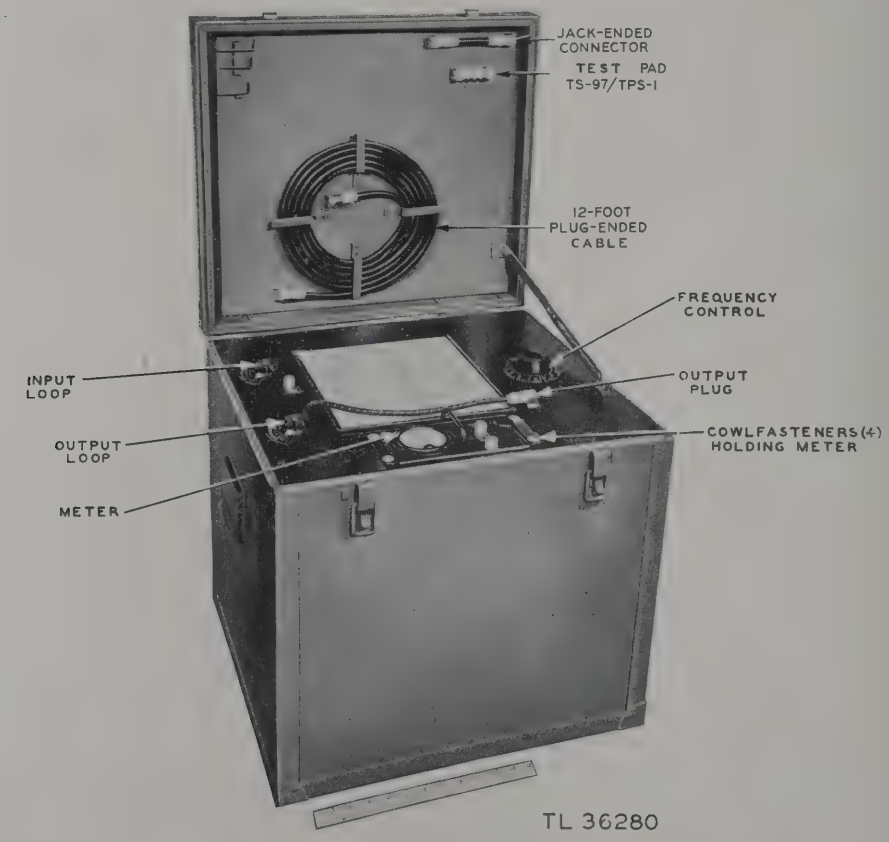


Figure 61. Test Set TS-91/TPS-1, cover opened.

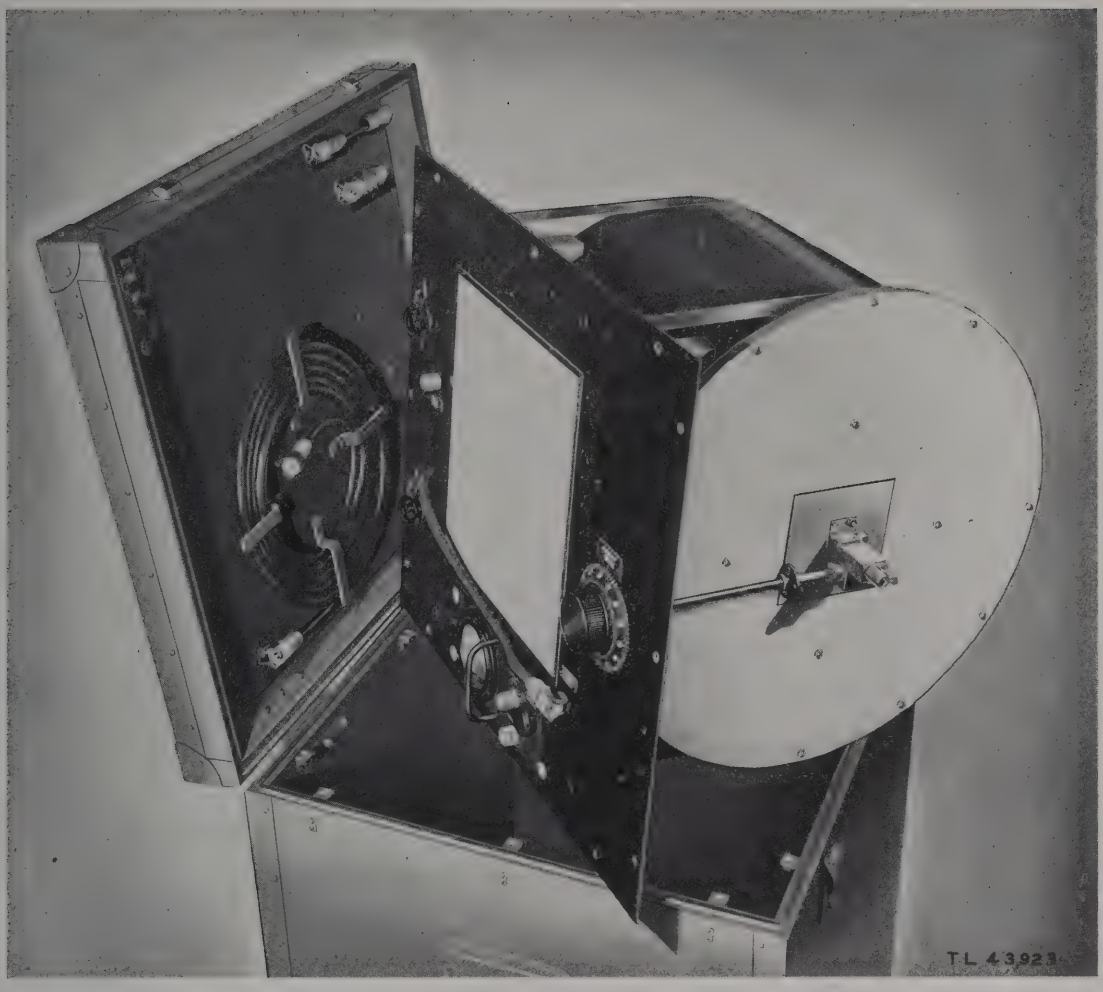


Figure 62. Test Set TS-91/TPS-1, resonant cavity removed from case.

It also explains why the cavity continues to oscillate for a comparatively long time after the incoming pulse has ceased.

(3) The total energy stored up in the resonator, and consequently, the time required to dissipate this energy, depends upon the amplitude and duration of the radar pulse. Note that the ringtime may be reduced by any or all of the following conditions: cavity not tuned to transmitter frequency; transmitter power low; receiver not tuned to transmitter and cavity; receiver noise level abnormally high; excessive losses between transmitter and receiver (transmission lines, antenna systems, space between antennas, cavity, etc.).

(4) R-f energy from the radar transmission line is picked up by the test probe and is fed into the echo-box cavity through an r-f cable and a coupling loop. The same loop serves to pick up the energy charge in the cavity to feed back to the radio set receiver through the same probe connection. During the radar pulse, the resonant cavity of the echo box accepts r-f energy, and oscillations build up for the duration of the radar pulse. After the radar pulse, the oscillations in the echo box continue but gradually die out (fig. 60), because some of the energy is dissipated in the resonant cavity, some is coupled out to the crystal rectifier and microammeter, and some is coupled out to the transmission line. This latter energy is detected in the radar receiver, appearing on the PPI or

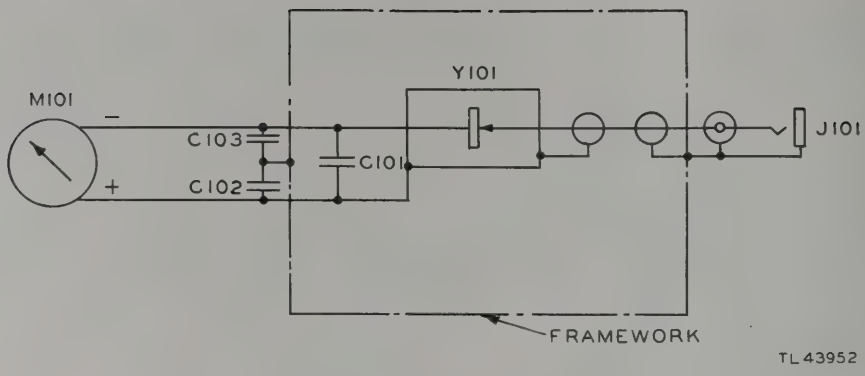


Figure 63. Test Set TS-91/TPS-1, schematic diagram.

Class A oscilloscope. The echo box, therefore, acts as a miniature transmitter which begins sending immediately after the radar pulse has been transmitted.

(5) Because of the large amount of power received and returned by the echo box, the received signals saturate the receiver for the greater part of the ringtime. This causes the ringtime to appear on the Class A oscilloscope as a solid block with a flat top. On the PPI oscilloscope the signal appears as a bright bar with its outer end diminishing in intensity. Later, when the amplitude of the oscillations is somewhat less, the indicator trace slopes downward from the flat top, to the noise or grass level on the oscilloscope. The time from the beginning of the transmitted pulse to the point where the signal from the echo box fades into the noise level is known as the ringtime of the box. The ringtime is measured either in time or distance, distance in miles being measured with the aid of the range markers, and time being computed at 10.8 microseconds per statute mile. A rise in noise level makes the echo box signal fade into the noise level at less mileage and thus shortens the ringtime.

(6) When the box is tuned to resonance, energy may be coupled out of the cavity into the crystal rectifier. The crystal current, filtered by a capacitor, is measured with a microammeter. This crystal current indicates the amount of r-f pulse energy absorbed by the echo box. Thus, the microammeter indication serves to indicate the radar power output.

(7) The observed ringtime is dependent upon several factors. Some of the constant factors, such as characteristics of the echo box, pick-up probe in the r-f line, cabling, and coupling loops in the echo box, are a part of the construction; they do not enter into any of the comparative measurements or indications. Other factors, such as power output of the transmitter, pulse duration, and receiver condition and tuning, vary with the performance of the radar system. Therefore, if all factors external to the radar system are constant, the ringtime will depend only upon the performance of the radar system.

CHAPTER 2
TROUBLE-SHOOTING PROCEDURES

SECTION I
GENERAL INFORMATION

27. INTRODUCTION.

No matter how well equipment is designed and manufactured, faults are bound to occur in service. When such faults do occur, the repairman must locate and correct them as rapidly as possible. This section contains general information to aid personnel engaged in the important duty of trouble shooting. (Remember, however, that preventive maintenance minimizes the necessity of trouble shooting.)

a. Trouble-shooting Data. Take advantage of the material supplied in this manual to help in rapidly locating faults. Consult the following trouble-shooting data when necessary.

(1) BLOCK DIAGRAM OF THE SYSTEM.

(2) COMPLETE SCHEMATIC DIAGRAMS. These diagrams include all components and show all the connections (power, input, and output) to other units.

(3) SIMPLIFIED AND PARTIAL SCHEMATICS. These diagrams are particularly useful in trouble shooting, because they enable the electrical functioning of the circuits to be followed more clearly than on the regular schematics, thus speeding trouble location.

(4) VOLTAGE AND RESISTANCE DATA AT SOCKET CONNECTIONS.

(5) VOLTAGE, RESISTANCE AND WAVEFORM DATA AT TEST JACKS. Blocking capacitors are omitted from most leads to the test jacks, to enable measurement of the d-c voltage at the plate or other points to which the test jacks connect. For this reason, be careful not to touch the measuring instruments which carry high voltage when connected to the test jacks.

(6) ILLUSTRATIONS OF COMPONENTS. Front, top, and bottom views aid in locating and identifying parts.

(7) PIN CONNECTIONS. Pin connections on sockets, plugs, and receptacles are numbered or lettered on the various diagrams.

(*a*) Seen from the bottom, pin connections are numbered in a clockwise direction around the sockets. On octal sockets the first pin clockwise from the keyway is pin No. 1. Pin numbers appear on both the schematic diagrams and the wiring diagrams, so that any tube element can be readily located.

(*b*) Plugs and receptacles are numbered on the side to which the associated connector is attached. To avoid confusion, some individual pins are identified by letters which appear directly on the connector.

b. Trouble-shooting Steps. The first step in servicing a defective radar set is to sectionalize the fault. *Sectionalization* means tracing the fault to the system responsible for the abnormal operation of the set. The second step is to localize the fault. *Localization* means tracing the fault to the defective part responsible for the abnormal condition.

(1) Use of the Equipment Performance Log (EPL) and the starting procedure aids in tracing the fault to the defective system. The procedures to be followed are explained in subparagraphs c and d.

(2) Some faults such as burned-out resistors, r-f arcing, etc., can be located by sight, smell, and hearing. The majority of faults, however, must be located by checking voltage, resistance, and waveforms.

c. Equipment Performance Log Sectionalization. The Equipment Performance Log is a record of the normal and abnormal operation of the station. In the event of station failure or abnormal operation, references to the Equipment Performance Log usually aids in sectionalizing the defect. When a station failure occurs, refer to the log sheet and note the operation of the station for the past 24 hours. The failure may be the result of a previous abnormal condition not serious enough in itself to have caused the station to go off the air at the time it occurred. The abnormal condition will have been entered in the station log. Check the log entry to obtain direct information leading to the cause of the failure.

d. Starting-Procedure Sectionalization. The starting procedure is the systematic method used to put the station on the air. This procedure is used in sectionalization when the cause of the station failure is not known. In most cases, it will trace the defect to a particular component. The steps of the starting procedure are performed in sequence until an abnormal result is obtained. As each step is performed, the visible and audible results of the action are noted. The use of the starting procedure is described in detail in section III of this chapter.

e. Localization. Localization is the tracing of the fault to a particular part. Sections IV to VIII of this chapter describe the method of localizing faults within the individual systems. These sections contain trouble-shooting charts which list abnormal symptoms and their causes. The charts also give the procedure for finding out which of the probable locations of the fault is the exact one. The sections also tell what waveforms should be obtained at the test points. In addition, there are drawings which show the resistance and the voltage at socket-pin connections. The method of using the voltage and resistance data in checking a circuit is described in detail in paragraphs 28d and 29c of this section.

28. VOLTAGE MEASUREMENTS.

a. General. Voltage measurements are an almost indispensable aid to the repairman, because most troubles either result from abnormal voltages or produce abnormal voltages. Voltage measurements are made easily, because they are always made between two points in a circuit and the circuit need not be interrupted.
(1) Information on normal operating voltages is given in the trouble-shooting section. Unless otherwise specified, these voltages are measured between the indicated points and ground.
(2) Always begin by setting the voltmeter on the highest range, so that the voltmeter will not be overloaded. Then, if it is necessary to obtain increased accuracy, set the voltmeter to a lower range.
(3) In checking cathode voltage, remember that a reading can be obtained when the cathode resistor is actually open. The resistance of the meter may act as a cathode resistor. Thus, the cathode voltage may be approximately normal only as long as the voltmeter is connected between cathode and ground. Before the cathode voltage is measured, a resistance check should be made with the circuit cold to determine if the cathode resistor is normal.

b. Precautions against High Voltage. Certain precautions must be followed when measuring voltages above a few hundred volts. High voltages are dangerous and can be fatal. When it is necessary to measure high voltages, observe the following rules:
(1) Connect the ground lead to the voltmeter.
(2) Place one hand in your pocket.
(3) If the voltage is less than 300 volts, connect the test lead to the hot terminal (which may be either positive or negative with respect to ground).
(4) If the voltage is greater than 300 volts, shut off the power, connect the hot test lead, step away from the voltmeter, turn on the power, and note the reading on the voltmeter. Do not touch any part of the voltmeter, particularly when it is necessary to measure the voltage between two points both of which are above ground.

c. Voltmeter Loading. It is essential that the voltmeter resistance be at least 10 times as large as the resistance of the circuit across which the voltage is measured. If the voltmeter resistance is comparable to the circuit resistance, the voltmeter will indicate a lower voltage than the actual voltage present when the voltmeter is removed from the circuit.
(1) The resistance of the voltmeter on any range can always be calculated by the following simple rule: resistance of voltmeter equals

the ohms-per-volt multiplied by the full-scale range in volts. Two examples are shown below:

(*a*) What is the resistance of a 1,000-ohm-per-volt voltmeter on the 300-volt range?

R = 1,000 ohms-per-volt × 300 volts = 300,000 ohms.

(*b*) What is the resistance of a 20,000-ohm-per-volt voltmeter on the 300-volt range?

R = 20,000 ohms-per-volt × 300 volts = 6 megohms.

(2) To minimize voltmeter loading in high-resistance circuits, use the highest voltmeter range. Although only a small deflection will be obtained (possibly only 5 divisions on a 100-division scale), the accuracy of the voltage measurement will be increased. The decreased loading of the voltmeter will more than compensate for the inaccuracy which results from reading only a small deflection on the scale of the voltmeter.

(3) When a voltmeter is loading a circuit, the effect can always be noted by comparing the voltage reading on two successive ranges. If the voltage readings on the two ranges do not agree, voltmeter loading is excessive. The reading (not the deflection) on the highest range will be greater than on the lowest range. If the voltmeter is loading the circuit heavily, the deflection of the pointer will remain nearly the same when the voltmeter is shifted from one range to another.

(4) The voltage tables and drawings given in this manual are based on readings taken with the multirange meter, Test Set TS-96/TPS-1, with 20,000 ohms-per-volt sensitivity. The trouble shooter should use a meter having the same ohms-per-volt sensitivity. The meter used in testing for the voltage will then produce the same amount of loading as the meter used in taking the voltage readings given in the tables and drawings, and it is unnecessary to consider the effect of loading.

d. Practical Example of Voltage Analysis. Figure 64 illustrates a typical amplifier stage. The values of the various parts are labeled as well as the input voltages. The normal voltages at the V3 tube socket pins are:

Pin No.	1	2	3	4	5	6	7	8
Voltage	7.2	6.3 ac	0	0	7.2	195	0	185

NOTE: All voltages are dc unless otherwise specified. The d-c readings were taken with a 1,000-ohm-per-volt voltmeter. Drawings for each component, giving the voltage at each socket connection, can be found in the section on trouble shooting in the component.

To check the stage shown in figure 64 for an abnormal voltage measurement, measure the voltages between the socket contacts and the chassis.

(1) The voltage between contact 1 and the

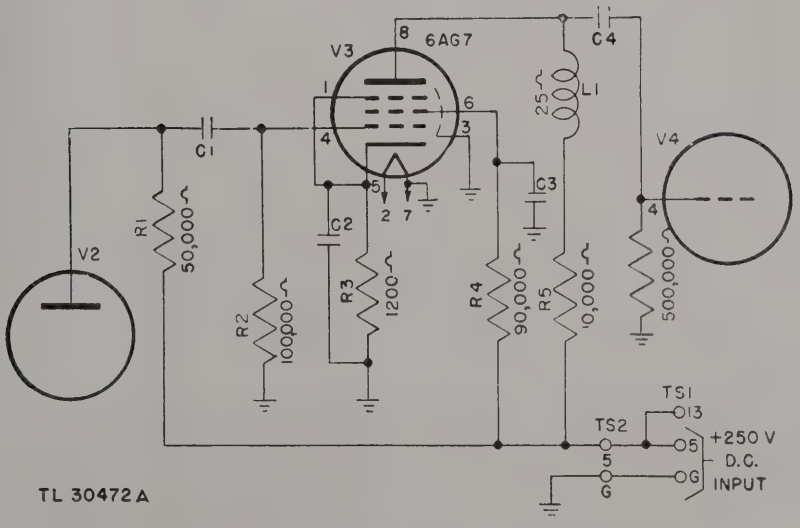


Figure 64. Schematic diagram for voltage analysis.

chassis is normally 7.2 volts (see above chart). This voltage should be the same as that between socket contact 5 and chassis, since they are directly connected (subpar. (5) below).

(2) The voltage between contact 2 and the chassis should be 6.3 a-c volts, since contact 2 is one side of the filament. On the diagram, no connections are shown because the filaments of amplifier tubes are always connected to a low-voltage a-c source. If this voltage is abnormal, check the voltage across the winding of the transformer which supplies the voltage.

(*a*) If the voltage of the transformer is normal, the trouble is a broken connection between the transformer and the contact.

(*b*) If the voltage of the transformer winding is abnormal, measure the voltage of the transformer primary winding.

(*c*) If the primary voltage is normal and the voltage on the winding that delivers the filament voltage is abnormal, either the transformer is defective or an abnormally high drain is being placed on the filament winding. This can be checked by removing one of the wires from the filament winding and again testing the voltage across this winding. If the transformer is defective, the voltage reading will still be abnormal. If the transformer is normal, the voltage will be a little higher than usual. However, if the voltage on the transformer primary is abnormal, the source of this voltage must be checked.

(3) The voltage between contact 3 and the chassis should be zero, since this contact is directly connected to the chassis.

(4) The voltage between contact 4 and the chassis should be zero, since this is a Class A amplifier and normally no grid current flows through resistor R2. If capacitor C1 short-circuits, however, the high positive voltage on the plate of tube V2 is delivered to contact 4 and a d-c positive-voltage reading will be obtained. It is also possible for a short circuit inside tube to cause a reading on this contact.

(5) The voltage on contacts 1 and 5 should be 7.2 volts. [An important consideration in measuring cathode voltage is explained in paragraph 28a (3).] The plate-cathode voltage and the grid-cathode voltage normally cause a current to flow through the cathode resistor R3. This current is normally 0.006 ampere, since the resistor is rated at 1,200 ohms and the voltage across it is 7.2 volts.

$$I = \frac{E}{R} = \frac{7.2}{1{,}200} = 0.006 \text{ ampere.}$$

(*a*) If no voltage is obtained, the trouble may be a lack of the plate-supply voltage, a burned-out tube V3, a shorted resistor R3, a shorted capacitor C2 (this capacitor, if shorted, connects the cathode to the chassis), or a broken connection.

(*b*) If the voltage is low, the trouble may be a tube V3 with low emission, a leaky capacitor C2, an open-circuited resistor R4 or R5, a shorted capacitor C3 or C4, low plate-supply voltage, an open-circuited coil L1, a poor connection or a change in the resistance value of any of the resistors.

(*c*) If the voltage is too high, the trouble may be a gassy tube, a short-circuited resistor, too high an applied voltage or a connection in either the plate-cathode or screen grid-cathode circuits shorted by an external circuit.

(6) The screen voltage is checked as follows:

(*a*) The voltage on contact 6 should normally be 195 volts. The voltage drop across the resistor is normally 55 volts, since the voltage on one side of the resistor is 195 volts and 250 volts on the other side. The normal current through this resistor is 0.0006 ampere.

$$I = \frac{E}{R} = \frac{55}{90{,}000} = 0.0006 \text{ ampere.}$$

(*b*) If no voltage is obtained on contact 6, the trouble may be lack of applied voltage, an open-circuited resistor R4, a broken connection, or a shorted capacitor C3.

(*c*) If the voltage on contact 6 is too low, the trouble may be a gassy tube, a leaky capacitor C3, too low an applied voltage, or too low a bias voltage on the grid of tube V3 (grid is biased by the 7.2 volts on the cathode).

NOTE: A gassy tube or lowering of the grid bias of tube V3 increases the screen grid current. Increasing this current increases the voltage drop across resistor R4. If capacitor C3 is leaky or shorted, the screen grid of tube V3 will be connected near or at ground potential, lowering the voltage on contact 6. The current through resistor R4 will rise if capacitor C3 is shorted. Resistor R4 will be the only resistance between the applied voltage and the chassis ground. Resistor R4 probably will burn out because of the high current flow unless the resistor has a high power rating. Any fault that makes high current flow through the screen grid-cathode circuit may burn out either resistor R3 or R4.

(7) The voltage between contact 7 and ground normally should be zero, according to the chart above, since this contact is connected directly to the chassis ground.

(8) The plate voltage is checked as follows:

(*a*) The voltage between contact 8 and the chassis normally should be 185 volts. This voltage is at one of the points in the plate-cathode circuit which comprises resistor R5, coil L1, the plate resistance of tube V3, and resistor R3. The applied voltage in this circuit is +250 volts. The voltage drop across resistor R5 and coil L1 in series is 65 volts (250 volts — 185 volts). The current through resistor R5 and coil L1 is 0.0064 ampere.

$$I = \frac{E}{R} = \frac{65}{10{,}025} = 0.0064 \text{ ampere.}$$

(*b*) If no voltage is obtained on contact 8, the trouble may be a lack of applied voltage, an open-circuited resistor R5 or coil L1, or a broken connection between terminal 5 on terminal strip TS1 and contact 8.

(*c*) If the voltage on contact 8 is too low, the trouble may be a gassy tube V3, too low an applied voltage, a shorted or leaky capacitor C2, or a shorted resistor R3. A gassy tube V3, shorted or leaky capacitor C2, or shorted resistor R3 will cause the current through the plate-cathode circuit to rise, increasing the voltage drop across resistor R5 and coil L1. This will lower the voltage on contact 8. Increased current through this circuit may also burn out resistor R3 or R5, unless their power rating is ample.

(*d*) If the voltage is too high, the trouble may be a burned-out tube V3, low emission in tube V3, a burned-out resistor R3, a shorted resistor R5, too high an applied voltage, or a burned-out resistor R4. If the tube is burned out or resistor R3 is open, no current will flow through the plate-cathode circuit, and there will be no voltage drop between the applied voltage and the plate of the tube.

(9) Capacitor C4, a coupling capacitor to the grid of tube V4, can be checked for a shorted or leaky condition by measuring the voltage between contact 4 on tube V4 and the chassis ground. If the positive d-c voltage is higher than normal when measured on contact 4 of tube V4, the capacitor is either leaky or shorted.

29. RESISTANCE MEASUREMENTS.

a. General. (1) NORMAL RESISTANCE VALUES. When a fault develops in a circuit, its effect will very often show up as a change in the resistance values. To assist in the localization of such faults, trouble-shooting data includes the normal resistance values as measured at the tube sockets and at the test jacks. These values are measured between the indicated points and ground, unless otherwise stated. Often it is desirable to measure the resistance from other points in the circuit, in order to determine whether the particular points in the circuit are normal. The normal resistance values at any point can be determined by referring to the resistance values shown in the schematic diagram, or by use of the color code (fig. 65).

(2) PRECAUTIONS. (*a*) Before making any resistance measurements, turn off the power. An ohmmeter is essentially a low-range voltmeter and battery. If the ohmmeter is connected to a circuit which already has voltages in it, the needle will be knocked off scale and the voltmeter movement may be burned out.

(*b*) Capacitors must always be discharged before resistance measurements are made. This is very important when checking power supplies that are disconnected from their load. The discharge of the capacitor through the meter will burn out its movement and in some cases may endanger life.

(3) CORRECT USE OF LOW AND HIGH RANGES. It is important to know when to use the low-resistance range and when to use the high-resistance range of an ohmmeter. When checking the circuit continuity, the ohmmeter should be set on the lowest range. If a medium or high range is used, the pointer may indicate zero ohms, even if the resistance is as high as 500 ohms. When checking high resistances or measuring the leakage resistance of capacitors or cables, the highest range should be used. If a low range is used, the pointer will indicate *infinite* ohms, even though the actual resistance is less than a megohm.

(4) PARALLEL RESISTANCE CONNECTIONS. In a parallel circuit the total resistance is less than the smallest resistance in the circuit. This is important to remember when shooting trouble with the aid of a schematic diagram.

(*a*) When a resistance is measured and the value is found to be less than expected, make a careful study of the schematic to be certain that there are no resistances in parallel with the one that has been measured. Before replacing a resistor because its resistance measures too low, disconnect one terminal from the circuit and measure its resistance again, to make sure that the low reading does not occur because some part of the circuit is in parallel with the resistor.

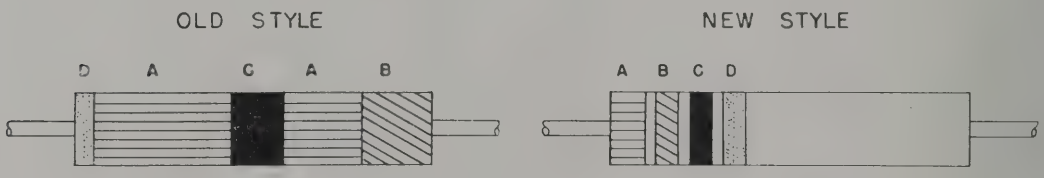
(*b*) In some cases a resistor cannot be checked because it has a low-voltage transformer winding connected across it. If the resistor must be checked, disconnect one terminal from the circuit before measuring its resistance.

(5) CHECKING GRID RESISTANCE. When checking grid resistance, a false reading may be obtained if the tube is still warm and the cathode is emitting electrons. Allow the tube to cool, or reverse the ohmmeter test leads so that the negative ohmmeter test lead is applied to the grid.

(6) TOLERANCE VALUES FOR RESISTANCE MEASUREMENTS. *Tolerance* means the normal difference that is expected between the rated value of the resistor and its actual value.

(*a*) Most resistors that are used in radar circuits have a tolerance of at least 10 percent. For example, the grid resistor of a stage might have a rated value of 1 megohm. If the resistor were measured and found to have a value

RESISTOR COLOR CODE



OLD STYLE	COLOR	NEW STYLE
BODY A	INDICATES FIRST SIGNIFICANT FIGURE OF RESISTANCE IN OHMS	BAND A
END B	INDICATES SECOND SIGNIFICANT FIGURE	BAND B
BAND OR DOT C	INDICATES MULTIPLIER	BAND C
END D	IF ANY, INDICATES TOLERANCE IN PER CENT OF THE NOMINAL RESISTANCE VALUE IF NO COLOR APPEARS TOLERANCE IS ± 20%	BAND D

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE PER CENT (IF GIVEN)
BLACK	0	1	
BROWN	1	10	
RED	2	100	
ORANGE	3	1,000	
YELLOW	4	10,000	
GREEN	5	100,000	
BLUE	6	1,000,000	
VIOLET	7	10,000,000	
GRAY	8	100,000,000	
WHITE	9	1,000,000,000	
GOLD		0.1	5
SILVER		0.01	10
NO COLOR			20

TL 35620

Figure 65. Resistor color code.

between 0.9 megohm and 1.1 megohms, it would be considered normal. As a rule, the ordinary resistors used in circuits are not replaced unless their values are off more than 20 percent. Some precision resistors and potentiometers are used. When a resistor is used whose value must be very close to its rated value, the tolerance is usually stated on the diagram.

(b) The tolerance values for transformer windings are generally between 1 and 5 percent. As a rule, suspect a transformer which shows a resistance deviating more than 5 percent from its rated value. Allow the transformer to cool off before the resistance test is made.

b. High-resistance Measurements. Many leakages will not show up when measured at low voltages. Most ohmmeters use a maximum test voltage of 15 volts on the highest resistance range. Where it is necessary to measure resistance above a few megohms or the leakage resistance between conductors of a cable, the test should be made using an applied voltage of 100 volts or more. Where it is possible to ground one end of the resistance being checked, one of the low-voltage power supplies in the equipment can be used to provide about 300 volts for making these high-resistance measurements. The manner in which such measurements are made is indicated in figure 66. This method should be used only when the resistance being measured is very high. Be careful not to handle the meter after the circuit has been completed. The meter used should have

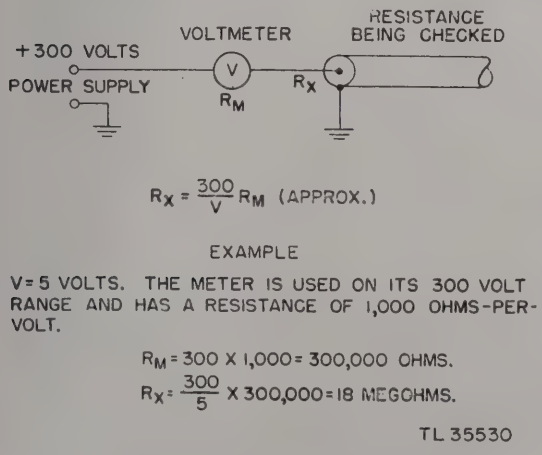

+300 VOLTS
POWER SUPPLY
VOLTMETER
V
R_M
R_X
RESISTANCE BEING CHECKED
$R_X = \frac{300}{V} R_M$ (APPROX.)
EXAMPLE
V=5 VOLTS. THE METER IS USED ON ITS 300 VOLT RANGE AND HAS A RESISTANCE OF 1,000 OHMS-PER-VOLT.
$R_M = 300 \times 1{,}000 = 300{,}000$ OHMS.
$R_X = \frac{300}{5} \times 300{,}000 = 18$ MEGOHMS.
TL 35530

Figure 66. Measurement of high resistance.

an ohms-per-volt sensitivity of 1,000 ohms or more. The resistance of the meter is equal to the ohms-per-volt sensitivity multiplied by the range to which the meter is set. The derivation of the formula $R_X = \frac{300R_m}{V}$ is shown below. R_X is the unknown resistance, R_m is the meter resistance, and V is the volt-meter reading.

$$\frac{R_X}{R_m} = \frac{300\text{-}V}{V}$$

If R_X is very large, V will be small in comparison to 300. Assuming that 300-V can be replaced by 300, the formula $\frac{R_X}{R_m} = \frac{300}{V}$ is obtained. When solved for R_X this gives $R_X = \frac{300R_m}{V}$. When making the measurement, the meter should first be put on the 300-volt scale to protect it in case R_X is very low. If the voltage used is not 300 volts, the correct value should be inserted in formula in place of 300.

c. Practical Example of Resistance Analysis. The low-voltage power supply shown in figure 67 will be used in this sample analysis. Suppose that a fuse in the primary circuit of the power transformer has blown out. The cause is obviously an overload. The overload may be a short circuit in the unit to which the power supply furnishes power, a short circuit in the power supply, or a short circuit in the primary circuit of the power transformer.

(1) Points 1, 2, 3, 4, 5, and 6 represent connections to a plug which takes power away from the power supply. Disconnect the plug and replace the blown fuse. (Since this is a low-voltage circuit, it is not likely that any damage will be done by blowing another fuse.) Turn the power on. If the fuse blows again, the trouble is not in the unit to which power is supplied.

(2) If the fuse blows the second time, the resistance between point 2 and ground should be checked. If this resistance is within 10 percent of 12,400 ohms (the sum of the resistances in the bleeder chain equals 12,400 ohms), the trouble is in the secondary or primary of the transformer. For this analysis, it will be assumed that the resistance is found to be much less than 12,400 ohms.

(3) If the resistance between point 2 and ground is found to be zero, capacitor C3 must be shorted. In order to test the capacitor, disconnect its lead from point M. The actual re-

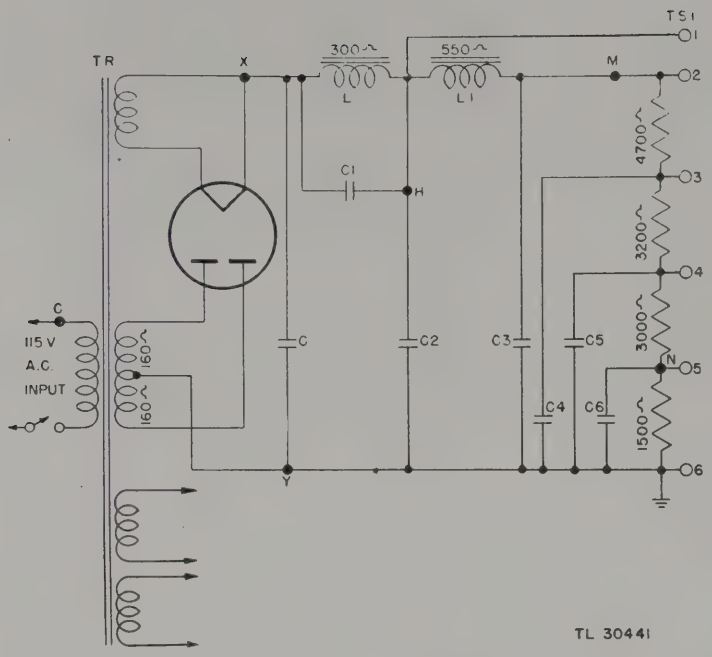


Figure 67. Schematic diagram for resistance analysis.

sistance of the capacitor can then be measured.
(4) A resistance between point 2 and ground of 550 ohms indicates that capacitor C2 is shorted, since coil L1 has a resistance of 550 ohms. Test capacitor C2 by disconnecting it from ground and measuring its resistance.
(5) A resistance between point 2 and ground of 850 ohms indicates a short circuit in the rectifier tube, the filament winding, or capacitor C. To discover which is shorted, remove the tube from its socket and again measure the resistance between point 2 and ground. If the fault is still present, it is either in capacitor C or in the filament winding. If the fault disappears when tube is removed, the fault is in the tube.
(6) If the resistance between point 2 and ground is about 1,000 ohms, the trouble is in the circuit either to the right or to the left of point M. To isolate the trouble disconnect the circuit at M. If the resistance between point 2 and ground is still much less than 12,400 ohms, the fault is in the bleeder chain. To check the chain, proceed as follows:

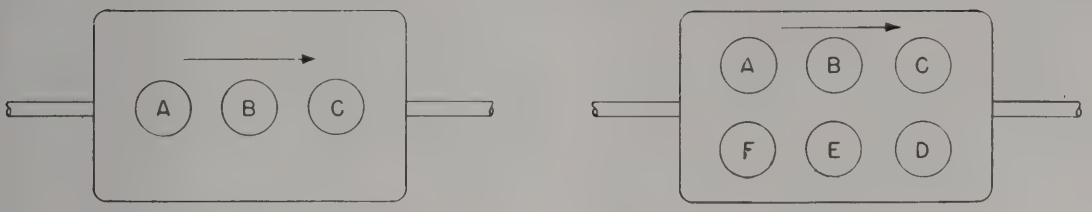
(*a*) Measure the resistance between points 2 and 3. If it is not close to 4,700 ohms, replace the resistor between these points.

(*b*) If the above check is satisfactory, check the resistance between point 3 and ground. From figure 67 it is seen that the reading should be 7,700 ohms. If the reading is zero, first disconnect capacitor C4 and check it. If capacitor C4 is normal, check the 3,200-ohm resistor. If the resistance between point 3 and ground is greater than zero but much less than 7,700 ohms, disconnect capacitors C4, C5, and C6 from the circuit. Then check the capacitors and the 1,500-ohm and 3,000-ohm resistors individually.

30. CAPACITOR TESTS.

Capacitors which are leaky or shorted can be found by resistance checks of the stage. A capacitor which is suspected of being open can best be checked by shunting a good capacitor across it. In intermediate-frequency (i-f) circuits, keep the lead to the capacitor as short as the original capacitor leads. In video and low-frequency circuits (less than 1 megacycle) the test capacitor leads may be several inches long. A capacitor color code is shown in figure 68 for checking the capacitor value against the value shown on the circuit diagram.

CAPACITOR COLOR CODE



ONE ROW DOTS	COLOR	TWO ROWS OF DOTS
DOT A	INDICATES FIRST SIGNIFICANT FIGURE OF CAPACITANCE VALUE IN MICROMICROFARADS	DOT A
DOT B	INDICATES SECOND SIGNIFICANT FIGURE	DOT B
	INDICATES THIRD SIGNIFICANT FIGURE	DOT C
DOT C	INDICATES MULTIPLIER	DOT D
USUAL TOLERANCE ±20%	INDICATES TOLERANCE IN PER CENT OF THE NOMINAL CAPACITANCE VALUE. IF NO COLOR APPEARS TOLERANCE IS 20%	DOT E
RATED VOLTAGE USUALLY 500 VOLTS	INDICATES THE RATED VOLTAGE	DOT F

COLOR	SIGNIFICANT FIGURE	MULTIPLIER	TOLERANCE PER CENT (IF GIVEN)	RATED VOLTAGE (IF GIVEN)
BLACK	0	1		
BROWN	1	10	1	100
RED	2	100	2	200
ORANGE	3	1000	3	300
YELLOW	4	10,000	4	400
GREEN	5	100,000	5	500
BLUE	6	1,000,000	6	600
VIOLET	7	10,000,000	7	700
GRAY	8	100,000,000	8	800
WHITE	9	1,000,000,000	9	900
GOLD		0.1	5	1,000
SILVER		0.01	10	2,000
NO COLOR			20	500

TL 35619

Figure 68. Capacitor color code.

31. CURRENT MEASUREMENTS.

Current measurements, other than those indicated by the panel meters, are not ordinarily required in trouble shooting in the radar set. Under special circumstances where the voltage and resistance measurements by themselves are not sufficient to localize the trouble, a current measurement can be made by opening the circuit and connecting an ammeter to measure the current. This procedure is not recommended except in very difficult cases.

a. When the meter is inserted in a circuit to measure current it should always be inserted away from the r-f end of the resistance. For example, when measuring *plate* current, do not insert the meter next to the plate of a tube,

but insert it next to the end of the resistor which connects to the power. This precaution is necessary to keep the meter from upsetting the r-f voltages.

> **CAUTION:** A meter has least protection against damage when it is used to measure current. Always set the current range to the highest value. Then, if necessary, decrease the range to give a more accurate reading. Avoid working close to full-scale reading because this increases the danger of overload.

b. In most cases, the current to be measured flows through a resistance which is either known or can be measured with an ohmmeter. The current flowing in the circuit can be determined by dividing the voltage drop across the resistor by its resistance value. The drop across the cathode resistor is a convenient method of determining the cathode current. For an example, see paragraph 28d.

32. TUBES.

a. Tube Failures. Tube failures are responsible for a large percentage of the faults which occur in radar sets. There are, however, too many tubes in a radar set for a trouble shooter to attempt to find a fault by indiscriminate tube changing.

(1) When putting a new tube into a circuit, note the position of all controls before making any changes. If retuning the controls with the new tube in the circuit does not correct the abnormal condition, return the controls to their original positions and put the old tube back in the circuit, unless a tube test shows the tube to be definitely bad.

> **CAUTION:** In many radar circuits the interelectrode capacitance of a tube is a part of a tuned circuit. When tubes are switched, the tuning of the circuits is upset. If too many tube substitutions are made, the set may become seriously misaligned.

(2) When replacing a tube in a circuit, decide at once whether or not to keep the old tube. Do not change the tubes indiscriminately, or the spares box will become full of tubes whose exact age and condition is uncertain.

b. Tube Checking. Tube checkers are used to check the emission of electrons from the cathode and to test for shorted elements. Tube checkers will not test the performance of high-voltage tubes or rectifiers or of some special tubes in the modulator and rectifier. Tube checkers are useful, however, for checking receiving-type tubes used in the various components.

(1) Results obtained from a tube checker are not always conclusive, because the conditions are not the same as those under which the tube operates in the set. For this reason, the final test of a tube must be its replacement with a tube which is known to be good. In many cases it is quicker and more reliable to replace a suspected tube with a good one than to check it with the tube checker.

(2) An operating chart and an instruction book are provided with the tube checker. This chart indicates the setting of the tube checker for each tube type. The number of controls, their arrangement; and their settings vary with different types of tube checkers.

33. CHECKING WAVEFORMS.

a. Signal Tracing. Basically, *signal tracing* means following the progress of a signal through a circuit. By *signal* is meant a video signal, a sweep voltage, a wide-gate voltage, or any other waveform which appears in the various parts of the equipment. A departure from the normal waveform indicates a fault located between the point where the waveform is last normal and the point where it is observed to be abnormal. For example, if a waveform is observed to be normal at the grid of a stage and abnormal at the plate of the same stage, this indicates that the trouble lies in that stage.

(1) When the waveform of a multivibrator, a blocking oscillator tube, or a similar circuit is found to be abnormal, replace the tube before making any further tests. If replacing the tube does not correct the waveform of the original tube, place it back in the socket.

(2) When a component does not give the expected waveform, the fault is not necessarily in the component. The abnormal waveform may be due to the absence of a synchronizing or triggering pulse from another component. The point at which to start signal-tracing a component is at the input trigger plug.

(3) It is sometimes desirable to know de-

finitely whether a signal voltage is getting to the grid of the first tube in a channel. To determine this when a test jack is not provided, remove the first tube in the channel involved so as to make the grid connection of the tube available from the top of the chassis. Then insert the test lead of the oscilloscope in the grid connection of the tube socket in order to see the waveform.

b. Use of Test Oscilloscope. Waveforms are the basis of radar operation. The outstanding advantage of the oscilloscope is that it can be used to observe and to measure waveforms at the various test jacks and at other points in the equipment. By comparing the observed waveform with the actual reference waveform shown in the data, the fault can be rapidly localized. However, if waveforms are measured at random, without a logical procedure such as that originating with the starting procedure, the result may be a loss of time in finding the fault. The measurement of waveforms with the test oscilloscope involves several essential points:

(1) INITIAL ADJUSTMENTS. The oscilloscope must be set up according to the manufacturer's instructions.

(2) SWEEP FREQUENCY. Adjust the frequency of the sweep until it is lower than the repetition frequency of the waveform being observed. For ordinary measurements, adjust the sweep frequency so that 2 or 3 cycles of the waveform appear on the screen. If more detail is desired, increase the sweep amplitude to spread the waveform.

(3) SIXTY-CYCLE WAVEFORMS. Some of the waveforms have a fundamental or repetition frequency of 60 cycles. In observing these waveforms the sweep frequency can be set so that 2 cycles of the waveform are observed.

(4) SYNCHRONIZATION. Avoid excessive synchronizing voltage. If the SYNC control is advanced too far, the sweep becomes nonlinear with the result that the waveform is distorted. Be sure that the fine frequency control on the oscilloscope is properly set so as to obtain a nearly stationary image. Then advance the SYNC control only far enough to make the trace stationary.

(5) SIXTY-CYCLE PICK-UP. If some fault is present, it may be impossible to obtain a stationary pattern even though the oscilloscope frequency control is properly adjusted. This effect is usually due to the presence of 60-cycle modulation or 60-cycle pick-up combined with the observed waveform. To check, turn the oscilloscope sweep frequency to 30 cycles. If the effect is due to line pick-up, a stationary pattern will be observed. The inside of this pattern will, of course, be more or less "filled," because of the much higher frequency of the waveform being observed.

(6) REACTIONS OF OSCILLOSCOPE ON WAVEFORM. Remember that the oscilloscope, because it shunts capacitance and resistance across the circuit, modifies the actual operating waveforms present in the circuit. This does not affect the usefulness of waveform measurements. The reference waveforms shown in this manual were taken with a typical oscilloscope under the conditions that are present when the repairman takes the waveforms.

(7) TEST LEADS. Avoid the use of a shielded test lead or twisted leads when taking waveforms. Each of these shunts a capacitance across the circuit under test, causing the waveform to be distorted and therefore different from that shown in the data. The waveforms shown in the test data were taken by using an unshielded lead. The ground lead should be connected at all times.

(*a*) Keep the ungrounded oscilloscope test lead away from other circuits to avoid introducing feedback. The test leads should be brought from the test points in a way which introduces the minimum amount of coupling to other stages.

(*b*) The leads to the oscilloscope must be kept short when measuring grid voltages from circuits where the grid capacitors are small. The smallest reaction on the waveform is introduced when measuring the voltage across the output (cathode) of a cathode follower or of any low-impedance circuit.

(*c*) In measuring waveforms in high-impedance circuits, do not handle the *hot* test lead. If this precaution is not observed, the waveform will be distorted as a result of loading the circuit and picking up 60-cycle voltage.

(*d*) If a signal voltage is picked up on the test leads, the oscilloscope indication may be misleading. For example, a signal may appear on the oscilloscope even when a plate-to-grid coupling capacitor is open. This effect occurs

most often in circuits carrying narrow-pulse waveforms. It can be recognized by the fact that the waveform is reduced in amplitude below the normal and is distorted because the high-frequency components are overemphasized.

(8) R-F and I-F CIRCUITS. Do not attempt to measure voltages or waveforms in any of the r-f or i-f circuits. These frequencies are beyond the range of ordinary test oscilloscopes, and no indications useful in trouble shooting can be obtained.

(9) REVERSING LINE PLUG. In some instances, a more stable pattern may be obtained by reversing the a-c line plug of the oscilloscope circuit. This may reduce the amount of 60-cycle pick-ups, if they happen to be troublesome.

(10) RELATIVE AMPLITUDE. In following the path of the signal through a component, the amplitude of the waveform usually increases as the checking point is advanced from the input stage toward the output stage. As the reference waveforms show, however, this is not always true. For example, when going from the grid to the cathode of the cathode-follower stage, there is a loss in signal amplitude of about 10 percent. This is a normal condition. Another example is in connection with wave-shaping circuits, where a decrease in the width of a signal is sometimes accompanied by a decrease in amplitude (as in differentiating circuits).

(11) CALIBRATION. If it is necessary to measure the actual voltage of the waveform, the oscilloscope must be calibrated. Calibrate the oscilloscope by finding how many volts correspond to a 1-inch deflection on the screen. This is the sensitivity of the scope.

(12) HIGH-VOLTAGE MEASUREMENTS. When voltages above a few hundred volts are measured, connect the test lead with the power turned off.

> **CAUTION:** Some test jacks do not have blocking capacitors. The capacitors are left out so that d-c voltages can be measured at the test jacks.

c. Comparison of Waveforms. If there is no fault in the circuit or equipment, an actual waveform taken at a point in the equipment should closely resemble the reference waveform. In some cases, however, differences in shape may occur for the following reasons:

(1) The test leads to the oscilloscope may not be placed in the same manner.

(2) A different oscilloscope may be used, having values of input resistance and capacitance which differ from those of the oscilloscope used in taking the reference waveforms.

(3) The various controls in the equipment may not be in the same positions as when the reference waveforms were taken. Note the conditions specified for the reference waveform.

(4) The same number of cycles may not be present.

(5) The vertical or horizontal amplitudes of the reference and the test patterns may not be proportional. This will produce apparent differences between the shapes of the two waveforms, when there is actually no real difference.

(6) Whether or not a waveform is regarded as abnormal depends upon the symptom accompanying the fault which is being traced. The discrepancy is considered significant if the fault can be caused by a minor difference in waveform at the point under test. Otherwise time should not be spent in hunting down the cause of relatively minor differences between the shapes of the reference waveforms and the test waveforms.

34. USE OF SIGNAL GENERATOR.

Signal generators are used to locate defective stages in radar receivers and to align the i-f amplifiers.

a. Signal Tracing. The signal generator output is fed to the first i-f stage, and the progress of the signal is then traced through the receiver. The procedure is as follows:

(1) Set the signal generator frequency to the i-f frequency of the radar receiver. The output of the signal generator should be amplitude-modulated at an audio-frequency rate of between 400 and 10,000 cycles per second. For information concerning the setting up of the signal generator, refer to the manufacturer's handbook accompanying the signal generator.

(2) Make the leads from the signal generator to the receiver as short as possible. Insert a coupling capacitor in the hot lead. For frequencies above 20 megacycles the capacitance of the coupling capacitor should be around 0.005 microfarad.

(3) The i-f signal should be coupled by means of the coupling capacitor to the grid of the first i-f stage. If no output is shown on the radar oscilloscopes, connect a test oscilloscope to the plate of the detector. If no output is seen on the oscilloscope, the fault lies in or between the first i-f amplifier and the detector (subpar. (*a*) below. If a sinusoidal waveform having the same frequency as the chosen modulating frequency is seen, the i-f stages and the detector are operating. In that case, the test oscilloscope should be connected to the plate of the output stage of the receiver. If no output is seen there, the fault lies in or between the first video amplifier and the output stage (subpar. (*b*) below).

(*a*) If the fault is found to be in the i-f stages or in the detector, connect the signal generator to the grid of the middle stage of the i-f amplifier. If there is a normal output from the detector, the fault is in one of the first i-f stages. If the detector has no output, the fault is in or between the middle stage and the detector. By moving the signal generator output either forward or backward, stage by stage, the faulty stage can be rapidly located. In order to locate the defective part in the stage, change the tube. If replacing the tube does not clear up the fault, make resistance and voltage checks of the stage.

(*b*) If the fault is found to be in the video amplifiers, leave the signal generator connected to the first i-f stage and move the test oscilloscope from the grid to the plate of each video stage until the defective stage is located. If changing the tube does not correct the fault, make resistance and voltage checks to locate the defective part.

b. I-f Alignment. A signal generator is used in aligning i-f stages. The modulated output is fed to the grid of the stage preceding the stage being aligned. This is done to prevent the shunting effect of the signal generator from upsetting the circuit being aligned. The stage closest to the detector is aligned first. By working backward through the i-f stages, they are all brought into alignment. Each stage is adjusted to produce maximum indication on the oscilloscope. Adjust the stages with a nonmetallic aligning tool. If no tool is available, one can be made from a dry wooden rod. At all times, use the minimum signal generator output that will produce a satisfactory indication.

35. REPLACING PARTS.

Careless replacement of parts often makes new faults inevitable. Note the following points:

a. Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections to it, tag each of the leads.

b. Be careful not to damage other leads by pulling or pushing them out of the way.

c. Do not allow drops of solder to fall into the set, since they may cause short circuits.

d. A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, since a poorly soldered joint is one of the most difficult faults to find.

e. When a part is replaced in r-f or i-f circuits, it must be placed exactly as the original one was. A part which has the same electrical value but different physical size may cause trouble in high-frequency circuits. Give particular attention to proper grounding when replacing a part. Use the same ground point as in the original wiring. Failure to observe these precautions may result in decreased gain or possibly in oscillation of the circuit.

SECTION II
USE OF SPECIALIZED TEST EQUIPMENT

36. TEST SET TS-91/TPS-1 (ECHO BOX).

a. General. An echo box (fig. 61) is furnished for system operational checks. This is a tunable ringing cavity which can be coupled to the antenna transmission line to provide a receiver response which aids in lining up the set. The meter panel in this test set is removable and may be used separately as a crystal detector. A chart attached to the panel is reproduced in figure 69.

b. Echo Box Accessory Equipment. (1) CABLE. A 12-foot plug-ended cable, coded red, is provided for connecting the echo box to the transmission line probe jack on the r-f unit. This cable is stored in the cover of the echo box.

(2) 10-DB PAD. One 10-db pad, TS-97/TPS-1, is provided and is stored in the cover of the echo box.

(3) CONNECTOR. One jack-ended connector is provided. It is stored in the cover of the echo box.

c. Trouble Shooting the Echo Box. The simplicity and mechanical construction of the echo box eliminates the possibility of all but a few minor troubles. In most cases such mechanical troubles can be easily repaired. Proper lubrication of all movable joints and connections and proper protection to keep water out of the echo box should prevent these troubles.

(1) FREQUENCY CONTROL KNOB. A broken or defective FREQUENCY CONTROL is indicated by inability to tune the echo box cavity. Such a defect is mechanical and can be located by inspection of the control and the associated mechanism which raises or lowers the metal disc varying the size of the echo box cavity.

(2) INPUT LOOP OR OUTPUT LOOP CONTROL. Defective INPUT LOOP or OUTPUT LOOP control is indicated by inability to cause a change in meter reading by varying the control. Inspect the inoperative control to locate the defect.

(3) COUPLING LOOPS. A broken or defective input coupling loop is indicated by inability to obtain an indication of ringtime on the Class A oscilloscope when tuning the echo box. A broken or defective output coupling loop is indicated by inability to obtain a meter reading on the echo box meter although normal indication of ringtime is present on the oscilloscope. Defective or broken loops can best be detected by inspection.

(4) REPLACEMENT OF CRYSTALS.

(*a*) *Precautions.*

1. The electrical characteristics of the cartridge-type crystal will be impaired seriously if excessive electrical currents pass through the unit. Minute static charges, not readily detectable, are sufficient to cause damage. The possibility of a static discharge through the crystal should therefore be prevented. Static may be accumulated, particularly in dry weather, by motion of the operator's feet across an insulated floor. If the apparatus into which the crystal is to be inserted is not grounded, the apparatus may have accumulated a static charge. *The possibility of damage may be avoided by touching the crystal block with the hand, which holds the new crystal, before and while inserting the new crystal in the block.*
2. The power absorbed from a strong electromagnetic field may be sufficient to overload and damage a crystal. Units, therefore, should never be exposed to strong fields. If it is necessary to remove the crystal from the crystal holder or from the spare crystal container when in the vicinity of a radar transmitter, *first stop the operation of the transmitter.* Keep crystals, which are not mounted in the set, wrapped in lead foil or stored in a metal box.
3. Do not drop crystal units or otherwise subject them to mechanical shock. Handle them as vacuum tubes are handled.

(*b*) *Procedure.* The crystal unit is contained in the crystal compartment on the meter panel. Spare crystals are contained in the spare crystal compartment, so labeled on the meter panel.

IA PERFORMANCE ANALYSIS WITH

EST SET

CE WITH MAINTENANCE AND OPERATING INSTRUCTIONS FURNISHED WITH THE EQUIPMENT

RMAL TESTS

G CAVITY

RE SHOWN IN FIG. A.
PLING LOOP AT 5 DIV.
DIAL FOR MAXIMUM METER READING AT THE
DJUSTING THE OUTPUT COUPLING LOOP TO
READING OF ABOUT 10 ON THE OUTPUT
HAVING THE OUTPUT METER GO OFF

READING CORRESPONDS TO THE
SMITTER FREQUENCY AND MAY BE COMPARED
FORMER RESULTS.

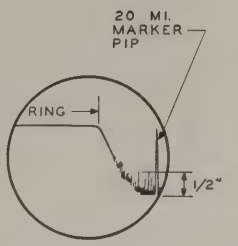
K OF RADAR

RE SHOWN IN FIG. B.
T SET AS IN TEST 1.
COUPLING LOOP TO (OUT)
OSCILLATOR TUNING FOR MAXIMUM
SEE FIG. 1 AT RIGHT.
UT LOOP COUPLING FOR MAXIMUM

EIVER GAIN FOR 1/2" NOISE PEAKS ON

ME, USING RANGE MARKER PIPS AS GUIDE.

ME IS A MEASURE OF THE OVERALL
M PERFORMANCE AND WITH CAREFUL
G MAY BE COMPARED WITH PREVIOUS RESULTS.



OVERALL CHECK

FIG. 1

JSTMENT

RE SHOWN IN FIG. B.
MENTS AS IN TEST 2, ABOVE.
T LOOP COUPLING UNTIL 10 MILE MARKER
ON SIDE OF DECAY TRACE. SEE FIG. 2 AT

DJUSTMENTS MAY NOW BE MADE ON TR BOX,
ERS AND CONVERTER TO MAXIMIZE THE
HE HEIGHT OF POINT A, FIG. 2, IS A
INDICATOR.

RECEIVER ADJUSTMENT

FIG. 2

LE INDICATIONS

ERFORMANCE

RE SHOWN IN FIG. A.
E ON THE "A" SCOPE, SUCH AS SHOWN IN
TES THAT THE MAGNETRON IS NOT
PERLY.
TUNING RANGE OF CAVITY FOR
TRANSMITTER FREQUENCIES, AS SHOWN BY
R.
OUPLINGS TO (IN) POSITION, EXCEPT WHEN
R GOES OFF SCALE **BE CAREFUL TO**
OVERLOAD AT THE MAIN RESONANCE
ETERMINED IN TEST 1.

IMPROPER PULSING

FIG. 3

TOR OUTPUT

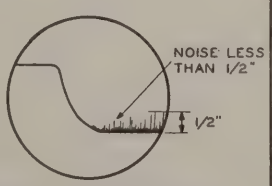
TO BE MADE WHEN IT IS NOT POSSIBLE TO
NOISE ON "A" SCOPE.
RE SHOWN IN FIG. C.
T METER READING WITH PREVIOUSLY
SULTS.

RYSTAL DETECTOR

RE SHOWN IN FIG. C.
DAR IS KNOWN TO BE IN GOOD OPERATING
NE PROCEDURE OF TEST 5 MAY BE USED TO
THE OUTPUT METER CRYSTAL HAS NOT
NTALLY BURNED OUT BY OVERLOAD.

OVERY

RE SHOWN IN FIG. A.
CE BETWEEN END OF RING AND THE RETURN
MAL NOISE TRACE. THIS SHOULD BE
EE FIG. 4 AT RIGHT.



IMPROPER RECEIVER RECOVERY

FIG. 4

TL 43924

Figure 69. Test Set TS-91/TPS-1 (echo box) instruction sheet.

SECTION II
USE OF SPECIALIZED TEST EQUIPMENT

36. TEST SET TS-91/TPS-1 (ECHO BOX).

a. General. An echo box (fig. 61) is furnished for system operational checks. This is a tunable ringing cavity which can be coupled to the antenna transmission line to provide a receiver response which aids in lining up the set. The meter panel in this test set is removable and may be used separately as a crystal detector. A chart attached to the panel is reproduced in figure 69.

b. Echo Box Accessory Equipment. (1) CABLE. A 12-foot plug-ended cable, coded red, is provided for connecting the echo box to the transmission line probe jack on the r-f unit. This cable is stored in the cover of the echo box.

(2) 10-DB PAD. One 10-db pad, TS-97/TPS-1, is provided and is stored in the cover of the echo box.

(3) CONNECTOR. One jack-ended connector is provided. It is stored in the cover of the echo box.

c. Trouble Shooting the Echo Box. The simplicity and mechanical construction of the echo box eliminates the possibility of all but a few minor troubles. In most cases such mechanical troubles can be easily repaired. Proper lubrication of all movable joints and connections and proper protection to keep water out of the echo box should prevent these troubles.

(1) FREQUENCY CONTROL KNOB. A broken or defective FREQUENCY CONTROL is indicated by inability to tune the echo box cavity. Such a defect is mechanical and can be located by inspection of the control and the associated mechanism which raises or lowers the metal disc varying the size of the echo box cavity.

(2) INPUT LOOP OR OUTPUT LOOP CONTROL. Defective INPUT LOOP or OUTPUT LOOP control is indicated by inability to cause a change in meter reading by varying the control. Inspect the inoperative control to locate the defect.

(3) COUPLING LOOPS. A broken or defective input coupling loop is indicated by inability to obtain an indication of ringtime on the Class A oscilloscope when tuning the echo box. A broken or defective output coupling loop is indicated by inability to obtain a meter reading on the echo box meter although normal indication of ringtime is present on the oscilloscope. Defective or broken loops can best be detected by inspection.

(4) REPLACEMENT OF CRYSTALS.

(*a*) *Precautions.*

1. The electrical characteristics of the cartridge-type crystal will be impaired seriously if excessive electrical currents pass through the unit. Minute static charges, not readily detectable, are sufficient to cause damage. The possibility of a static discharge through the crystal should therefore be prevented. Static may be accumulated, particularly in dry weather, by motion of the operator's feet across an insulated floor. If the apparatus into which the crystal is to be inserted is not grounded, the apparatus may have accumulated a static charge. *The possibility of damage may be avoided by touching the crystal block with the hand, which holds the new crystal, before and while inserting the new crystal in the block.*
2. The power absorbed from a strong electromagnetic field may be sufficient to overload and damage a crystal. Units, therefore, should never be exposed to strong fields. If it is necessary to remove the crystal from the crystal holder or from the spare crystal container when in the vicinity of a radar transmitter, *first stop the operation of the transmitter.* Keep crystals, which are not mounted in the set, wrapped in lead foil or stored in a metal box.
3. Do not drop crystal units or otherwise subject them to mechanical shock. Handle them as vacuum tubes are handled.

(*b*) *Procedure.* The crystal unit is contained in the crystal compartment on the meter panel. Spare crystals are contained in the spare crystal compartment, so labeled on the meter panel.

RADIO SET AN/TPS-1 OR AN/TPS-1A PERFORMANCE ANALYSIS WITH TS-91/TPS-1 TEST SET

TESTS AND ADJUSTMENTS ON THE APPARATUS SHOULD BE MADE IN ACCORDANCE WITH MAINTENANCE AND OPERATING INSTRUCTIONS FURNISHED WITH THE EQUIPMENT

NORMAL TESTS

FIG. A

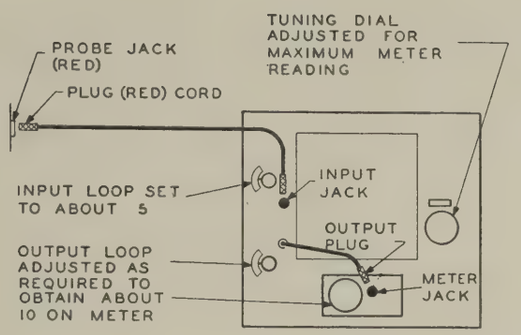

TUNING DIAL ADJUSTED FOR MAXIMUM METER READING
PROBE JACK (RED)
PLUG (RED) CORD
INPUT LOOP SET TO ABOUT 5
INPUT JACK
OUTPUT PLUG
OUTPUT LOOP ADJUSTED AS REQUIRED TO OBTAIN ABOUT 10 ON METER
METER JACK

FIG. B

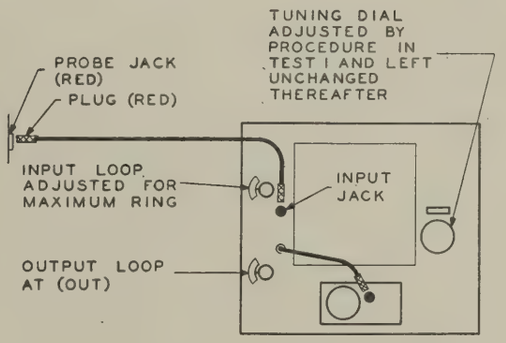
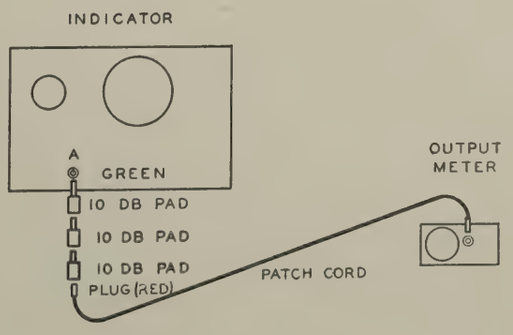

TUNING DIAL ADJUSTED BY PROCEDURE IN TEST 1 AND LEFT UNCHANGED THEREAFTER
PROBE JACK (RED)
PLUG (RED)
INPUT LOOP ADJUSTED FOR MAXIMUM RING
INPUT JACK
OUTPUT LOOP AT (OUT)

FIG. C



TEST 1 - TUNING RINGING CAVITY

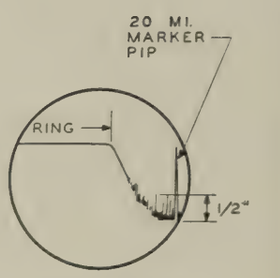
CONNECTIONS ARE SHOWN IN FIG. A.
SET INPUT COUPLING LOOP AT 5 DIV.
ADJUST TUNING DIAL FOR MAXIMUM METER READING AT THE SAME TIME ADJUSTING THE OUTPUT COUPLING LOOP TO MAINTAIN A READING OF ABOUT 10 ON THE OUTPUT METER. **AVOID HAVING THE OUTPUT METER GO OFF SCALE.**

DIAL READING CORRESPONDS TO THE TRANSMITTER FREQUENCY AND MAY BE COMPARED WITH FORMER RESULTS.

TEST 2 - OVERALL CHECK OF RADAR

CONNECTIONS ARE SHOWN IN FIG. B.
A. ADJUST TEST SET AS IN TEST 1.
B. SET OUTPUT COUPLING LOOP TO (OUT)
C. ADJUST BEAT OSCILLATOR TUNING FOR MAXIMUM RINGTIME. SEE FIG. 1 AT RIGHT.
D. ADJUST INPUT LOOP COUPLING FOR MAXIMUM RINGTIME.
E. ADJUST RECEIVER GAIN FOR 1/2" NOISE PEAKS ON "A" SCOPE.
F. READ RINGTIME, USING RANGE MARKER PIPS AS GUIDE.

RINGTIME IS A MEASURE OF THE OVERALL SYSTEM PERFORMANCE AND WITH CAREFUL READING MAY BE COMPARED WITH PREVIOUS RESULTS.

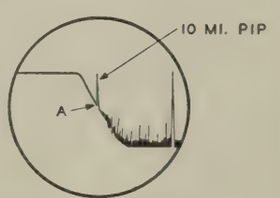


OVERALL CHECK

FIG. 1

TEST 3 - RECEIVER ADJUSTMENT

CONNECTIONS ARE SHOWN IN FIG. B.
A. MAKE ADJUSTMENTS AS IN TEST 2, ABOVE.
B. REDUCE INPUT LOOP COUPLING UNTIL 10 MILE MARKER PIP FALLS ON SIDE OF DECAY TRACE. SEE FIG. 2 AT RIGHT.
C. SLIGHT READJUSTMENTS MAY NOW BE MADE ON TR BOX, RF AMPLIFIERS AND CONVERTER TO MAXIMIZE THE RINGTIME. THE HEIGHT OF POINT A, FIG. 2, IS A SENSITIVE INDICATOR.



RECEIVER ADJUSTMENT

FIG. 2

TROUBLE INDICATIONS

TEST 4 - MAGNETRON PERFORMANCE

CONNECTIONS ARE SHOWN IN FIG. A.
AN EXTRA TRACE ON THE "A" SCOPE, SUCH AS SHOWN IN FIG. 3, INDICATES THAT THE MAGNETRON IS NOT PULSING PROPERLY.
EXAMINE ENTIRE TUNING RANGE OF CAVITY FOR EXTRANEOUS TRANSMITTER FREQUENCIES, AS SHOWN BY OUTPUT METER.
ADJUST LOOP COUPLINGS TO (IN) POSITION, EXCEPT WHEN OUTPUT METER GOES OFF SCALE **BE CAREFUL TO AVOID METER OVERLOAD AT THE MAIN RESONANCE POINT, AS DETERMINED IN TEST 1.**

IMPROPER PULSING

FIG. 3

TEST 5 - BEAT OSCILLATOR OUTPUT

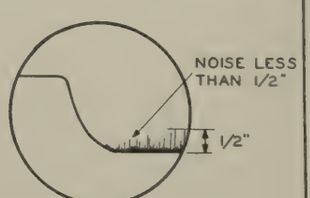
THIS TEST IS TO BE MADE WHEN IT IS NOT POSSIBLE TO OBTAIN 1/2" NOISE ON "A" SCOPE.
CONNECTIONS ARE SHOWN IN FIG. C.
COMPARE OUTPUT METER READING WITH PREVIOUSLY OBSERVED RESULTS.

TEST 6 - CHECK ON CRYSTAL DETECTOR

CONNECTIONS ARE SHOWN IN FIG. C.
WHEN THE RADAR IS KNOWN TO BE IN GOOD OPERATING CONDITION THE PROCEDURE OF TEST 5 MAY BE USED TO CHECK THAT THE OUTPUT METER CRYSTAL HAS NOT BEEN ACCIDENTALLY BURNED OUT BY OVERLOAD.

TEST 7 - RECEIVER RECOVERY

CONNECTIONS ARE SHOWN IN FIG. A.
OBSERVE DISTANCE BETWEEN END OF RING AND THE RETURN OF THE NORMAL NOISE TRACE. THIS SHOULD BE NEGLIGIBLE. SEE FIG. 4 AT RIGHT.



IMPROPER RECEIVER RECOVERY

FIG. 4

TL 43924

Figure 69. Test Set TS-91/TPS-1 (echo box) instruction sheet.

RADIO SET AN/TPS-1 OR AN/TPS-1A PERFORMANCE ANALYSIS WITH TS-91/TPS-1 TEST SET

TESTS AND ADJUSTMENTS ON THE APPARATUS SHOULD BE MADE IN ACCORDANCE WITH MAINTENANCE AND OPERATING INSTRUCTIONS FURNISHED WITH THE EQUIPMENT

NORMAL TESTS

FIG. A

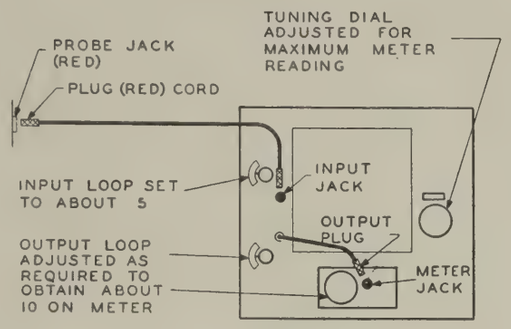

TUNING DIAL ADJUSTED FOR MAXIMUM METER READING
PROBE JACK (RED)
PLUG (RED) CORD
INPUT LOOP SET TO ABOUT 5
INPUT JACK
OUTPUT PLUG
OUTPUT LOOP ADJUSTED AS REQUIRED TO OBTAIN ABOUT 10 ON METER
METER JACK

FIG. B

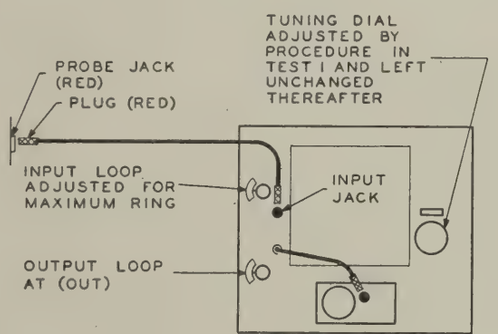
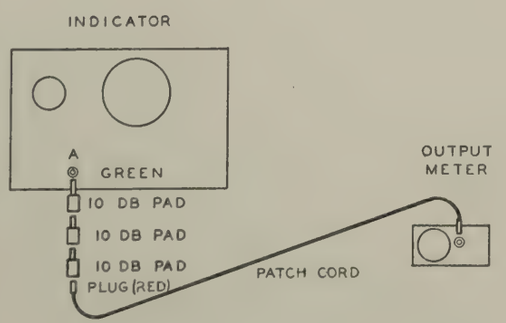

TUNING DIAL ADJUSTED BY PROCEDURE IN TEST 1 AND LEFT UNCHANGED THEREAFTER
PROBE JACK (RED)
PLUG (RED)
INPUT LOOP ADJUSTED FOR MAXIMUM RING
INPUT JACK
OUTPUT LOOP AT (OUT)

FIG. C



TEST 1 - TUNING RINGING CAVITY

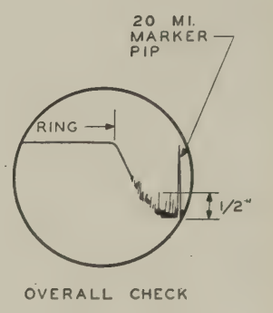
CONNECTIONS ARE SHOWN IN FIG. A.
SET INPUT COUPLING LOOP AT 5 DIV.
ADJUST TUNING DIAL FOR MAXIMUM METER READING AT THE SAME TIME ADJUSTING THE OUTPUT COUPLING LOOP TO MAINTAIN A READING OF ABOUT 10 ON THE OUTPUT METER. **AVOID HAVING THE OUTPUT METER GO OFF SCALE.**

DIAL READING CORRESPONDS TO THE TRANSMITTER FREQUENCY AND MAY BE COMPARED WITH FORMER RESULTS.

TEST 2 - OVERALL CHECK OF RADAR

CONNECTIONS ARE SHOWN IN FIG. B.
A. ADJUST TEST SET AS IN TEST 1.
B. SET OUTPUT COUPLING LOOP TO (OUT)
C. ADJUST BEAT OSCILLATOR TUNING FOR MAXIMUM RINGTIME. SEE FIG. 1 AT RIGHT.
D. ADJUST INPUT LOOP COUPLING FOR MAXIMUM RINGTIME.
E. ADJUST RECEIVER GAIN FOR 1/2" NOISE PEAKS ON "A" SCOPE.
F. READ RINGTIME, USING RANGE MARKER PIPS AS GUIDE.

RINGTIME IS A MEASURE OF THE OVERALL SYSTEM PERFORMANCE AND WITH CAREFUL READING MAY BE COMPARED WITH PREVIOUS RESULTS.

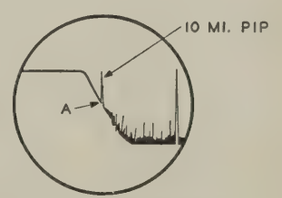


OVERALL CHECK

FIG. 1

TEST 3 - RECEIVER ADJUSTMENT

CONNECTIONS ARE SHOWN IN FIG. B.
A. MAKE ADJUSTMENTS AS IN TEST 2, ABOVE.
B. REDUCE INPUT LOOP COUPLING UNTIL 10 MILE MARKER PIP FALLS ON SIDE OF DECAY TRACE. SEE FIG. 2 AT RIGHT.
C. SLIGHT READJUSTMENTS MAY NOW BE MADE ON TR BOX, RF AMPLIFIERS AND CONVERTER TO MAXIMIZE THE RINGTIME. THE HEIGHT OF POINT A, FIG. 2, IS A SENSITIVE INDICATOR.



RECEIVER ADJUSTMENT

FIG. 2

TROUBLE INDICATIONS

TEST 4 - MAGNETRON PERFORMANCE

CONNECTIONS ARE SHOWN IN FIG. A.
AN EXTRA TRACE ON THE "A" SCOPE, SUCH AS SHOWN IN FIG. 3, INDICATES THAT THE MAGNETRON IS NOT PULSING PROPERLY.
EXAMINE ENTIRE TUNING RANGE OF CAVITY FOR EXTRANEOUS TRANSMITTER FREQUENCIES, AS SHOWN BY OUTPUT METER.
ADJUST LOOP COUPLINGS TO (IN) POSITION, EXCEPT WHEN OUTPUT METER GOES OFF SCALE **BE CAREFUL TO AVOID METER OVERLOAD AT THE MAIN RESONANCE POINT, AS DETERMINED IN TEST 1.**

IMPROPER PULSING

FIG. 3

TEST 5 - BEAT OSCILLATOR OUTPUT

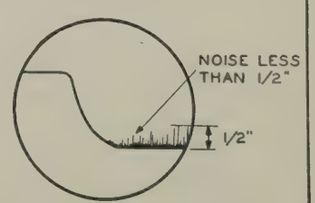
THIS TEST IS TO BE MADE WHEN IT IS NOT POSSIBLE TO OBTAIN 1/2" NOISE ON "A" SCOPE.
CONNECTIONS ARE SHOWN IN FIG. C.
COMPARE OUTPUT METER READING WITH PREVIOUSLY OBSERVED RESULTS.

TEST 6 - CHECK ON CRYSTAL DETECTOR

CONNECTIONS ARE SHOWN IN FIG. C.
WHEN THE RADAR IS KNOWN TO BE IN GOOD OPERATING CONDITION THE PROCEDURE OF TEST 5 MAY BE USED TO CHECK THAT THE OUTPUT METER CRYSTAL HAS NOT BEEN ACCIDENTALLY BURNED OUT BY OVERLOAD.

TEST 7 - RECEIVER RECOVERY

CONNECTIONS ARE SHOWN IN FIG. A.
OBSERVE DISTANCE BETWEEN END OF RING AND THE RETURN OF THE NORMAL NOISE TRACE. THIS SHOULD BE NEGLIGIBLE. SEE FIG. 4 AT RIGHT.



IMPROPER RECEIVER RECOVERY

FIG. 4

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Figure 69. Test Set TS-91/TPS-1 (echo box) instruction sheet.

To replace a crystal, remove the small knurled cap, pry out the old crystal by means of a screwdriver, nail, or other similar object, and insert the new crystal with the fingers.

37. USE OF ECHO BOX.

a. Preparing Echo Box for Use. Before making any of the tests or adjustments described below, the echo box must be tuned in the following manner.

(1) Set the INPUT LOOP knob of the echo box to position 5 on the scale.

(2) Connect the INPUT JACK on the echo box to the probe jack (red) on the r-f unit (fig. 70), using the cable stored in the cover of the echo box.

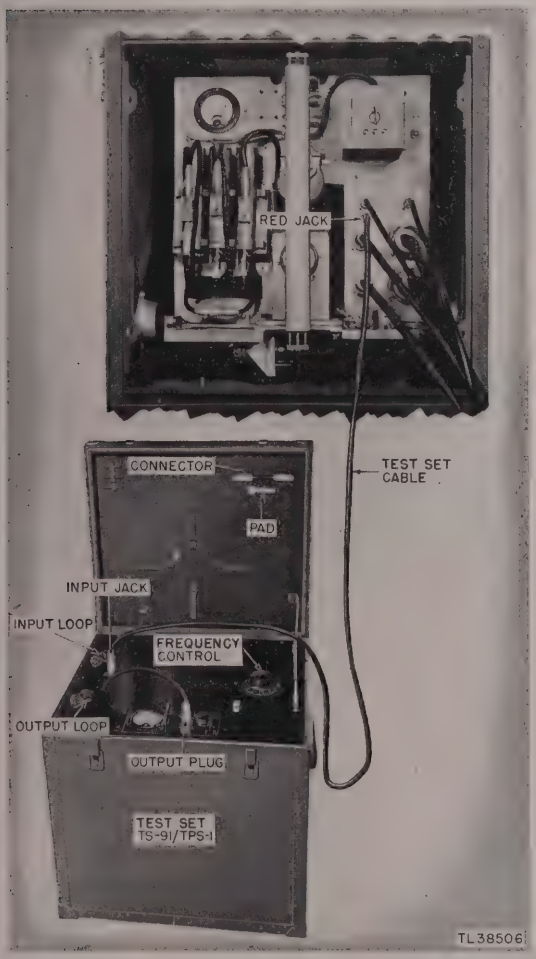


Figure 70. Echo box connections for frequency and power measurements and T-R box adjustment.

(3) Set the OUTPUT LOOP knob on the echo box to position OUT.

(4) Connect the OUTPUT PLUG on the echo box to the METER JACK.

(5) Observing the meter, tune the echo box with the FREQUENCY CONTROL to obtain a maximum deflection on the meter, at the same time adjusting the OUTPUT LOOP to obtain an adequate reading. Do not exceed 20 microamperes.

(6) With the tuned echo box thus connected to the probe jack, a pattern is formed on the Class A oscilloscope screen as shown in figure 71.

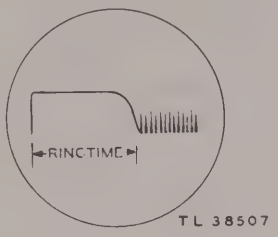


Figure 71. Echo box ringtime on Class A oscilloscope.

(7) Adjust the INPUT LOOP knob to obtain maximum ringtime on the Class A oscilloscope.

(8) Ringtime is used as a measure of receiver response in the following series of adjustments, except as noted.

(9) Note the scale reading on the FREQUENCY CONTROL dial of the echo box. This reading, when compared to a previous or subsequent reading, indicates approximately the shift in frequency of the magnetron oscillator if a shift has occurred, or the difference in frequency between the present and replaced magnetrons if a magnetron has been installed. Each FREQUENCY CONTROL dial scale division represents about 1 megacycle (mc), the frequency increasing with larger scale numbers.

b. For Tuning the T-R Box. (1) With the echo box connected to the probe jack (red) (subpar. a above), connect the T-R box output cord to the mixer input jack through a 10-db pad (which is clipped to the r-f unit panel above the T-R box).

(2) Check that the echo box is tuned to a maximum ringtime, and during the following steps recheck that the echo box has remained

To replace a crystal, remove the small knurled cap, pry out the old crystal by means of a screwdriver, nail, or other similar object, and insert the new crystal with the fingers.

37. USE OF ECHO BOX.

a. Preparing Echo Box for Use. Before making any of the tests or adjustments described below, the echo box must be tuned in the following manner.

(1) Set the INPUT LOOP knob of the echo box to position 5 on the scale.

(2) Connect the INPUT JACK on the echo box to the probe jack (red) on the r-f unit (fig. 70), using the cable stored in the cover of the echo box.

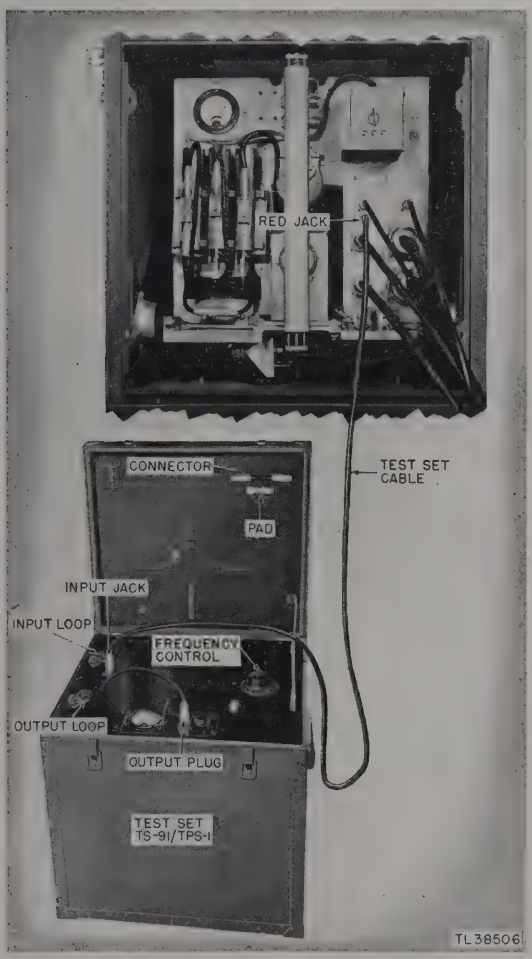


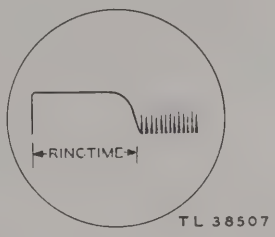
Figure 70. Echo box connections for frequency and power measurements and T-R box adjustment.

(3) Set the OUTPUT LOOP knob on the echo box to position OUT.

(4) Connect the OUTPUT PLUG on the echo box to the METER JACK.

(5) Observing the meter, tune the echo box with the FREQUENCY CONTROL to obtain a maximum deflection on the meter, at the same time adjusting the OUTPUT LOOP to obtain an adequate reading. Do not exceed 20 microamperes.

(6) With the tuned echo box thus connected to the probe jack, a pattern is formed on the Class A oscilloscope screen as shown in figure 71.



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(7) Adjust the INPUT LOOP knob to obtain maximum ringtime on the Class A oscilloscope.

(8) Ringtime is used as a measure of receiver response in the following series of adjustments, except as noted.

(9) Note the scale reading on the FREQUENCY CONTROL dial of the echo box. This reading, when compared to a previous or subsequent reading, indicates approximately the shift in frequency of the magnetron oscillator if a shift has occurred, or the difference in frequency between the present and replaced magnetrons if a magnetron has been installed. Each FREQUENCY CONTROL dial scale division represents about 1 megacycle (mc), the frequency increasing with larger scale numbers.

b. For Tuning the T-R Box. (1) With the echo box connected to the probe jack (red) (subpar. a above), connect the T-R box output cord to the mixer input jack through a 10-db pad (which is clipped to the r-f unit panel above the T-R box).

(2) Check that the echo box is tuned to a maximum ringtime, and during the following steps recheck that the echo box has remained

tuned. Tune with the TUNING knob on the indicator unit panel (fig. 44) to obtain maximum ring.

(3) Now tune the T-R box by loosening the right-hand clamping screw and turning the tuning screw (fig. 92) slowly in or out as necessary to obtain a maximum length of ring as viewed on the Class A oscilloscope. The use of a mirror is suggested to permit the man who does the tuning to observe the trace on the Class A oscilloscope.

(4) If the T-R box is considerably off-tune, loosen both right- and left-hand clamping screws and turn out both right and left tuning screws. Then, observing the ringtime on the Class A oscilloscope, turn in the left-hand tuning screw until a maximum ringtime is obtained. Unscrew the left-hand tuning screw about two turns, and clamp it. Then, to reobtain the maximum ringtime, turn in the right-hand tuning screw and clamp it. Fine adjustments of tuning can subsequently be made using the right-hand tuning screw.

(5) The ringtime observed will be rather short. A permanent echo appearing on the sloping side of the ringtime image can be used to improve the sensitivity of the indication of the tuning. Figure 71 represents such an image. A slight change in ringtime, causing the sloping side to move to the right or left, results in point A moving up or down.

c. For Tuning Preamplifiers. The two preamplifier assemblies have three adjustments each. Potentiometers labeled AMP 1 and AMP 2 control the cathode bias of the triode vacuum tube in the assembly. The bias voltage, checked between ground and the test point labeled AMP 1 and AMP 2 (fig. 32), should be 1 volt. If this reading is not obtained, turn AMP 1 screw on the r-f unit with a screwdriver until the meter indicates 1 volt. These controls are mounted in the potentiometer box. An inner cavity adjusting screw is provided at the amplifier for tuning the grid-plate circuit. This screw has a short knurled and slotted head and is located at the bottom of the assembly to the rear of the center line. An outer cavity adjusting screw is provided for tuning the grid-cathode circuit. This screw, which has a long knurled and slotted head, is located at the bottom of the assembly (fig. 92) to the left of the center line. It may be turned after loosening the knurled head clamping screw. Normally the outer cavity is not disturbed.

(1) Connect the echo box as outlined in subparagraph a above.

(2) Insert the preamplifier to be tuned between the T-R box and the 10-db pad at the mixer.

(3) Tune the preamplifier inner cavity for maximum ringtime on the Class A oscilloscope, turning the inner cavity tuning screw as required.

(4) Tune the outer cavity for maximum ringtime, turning the outer cavity tuning screw.

(5) Recheck the inner cavity tuning.

(6) Recheck the T-R box tuning. See subparagraph b above for procedure in tuning the T-R cavity.

(7) Retune the preamplifier outer cavity for its final adjustment, and lock it into position with the outer cavity clamping nut on the input jack assembly.

(8) Remove the pad from the circuit. Connect the parts in the usual order, that is, the T-R box cord to the input of preamplifier No. 1, the output of preamplifier No. 1 to the input of preamplifier No. 2, and the output of preamplifier No. 2 to the input of the mixer.

(9) Recheck the inner cavity tuning.

d. For Tuning Beat Frequency Oscillator. The beat frequency oscillator has two controls: the TUNING knob, which appears on the front panel and controls the tuning of the inner cavity of the oscillator assembly; and an outer cavity tuning screw located at the bottom of the assembly and adjustable with a screwdriver through a hole in the panel (fig. 32). The cathode current of the triode vacuum tube in the assembly is checked by measuring the voltage between test points OSC.— and OSC.+ (fig. 32) at the rear of the indicator unit chassis. This voltage should not be over 2.5 volts. If greater than 2.5 volts, reduce it by adjusting the outer cavity tuning.

(1) Connect the echo box as outlined in subparagraph a above.

(2) Tune the beat oscillator for maximum ringtime on the Class A oscilloscope by using the TUNING knob on the indicator unit panel.

e. For Tuning Mixer. The mixer has three adjustments. A potentiometer MOD located in the potentiometer box controls the cathode bias

of the triode vacuum tube. The bias, measured with a voltmeter between ground and the MOD test point (fig. 32), should be 1/2 volt. If this voltage is not obtained, turn MOD screw on the r-f unit with a screwdriver until the meter reads 1/2 volt. An outer cavity adjusting screw is provided for tuning the grid-cathode circuit of the triode tube to the r-f input. This screw, which has a short knurled head, is located at the bottom of the assembly to the left of the center line. An output circuit tuning screw is provided for tuning the output circuit to the intermediate frequency. This is a small slotted screw located at the bottom of the assembly in front of the center line.

(1) Connect the echo box as outlined in subparagraph a above.

(2) Tune the mixer input for maximum ringtime by rotating the outer cavity tuning screw at the left bottom of the mixer assembly.

(3) Connect the T-R box output cord to the r-f input jack of the mixer.

(4) Tune the 60-mc output circuit of the mixer.

(5) Replace preamplifiers No. 1 and No. 2 between the T-R box output and the r-f input jack of the mixer.

(6) Check the outer cavity tuning of the mixer.

(7) Check the inner cavity tuning of preamplifier No. 2.

f. For Measuring Output Power. (1) Connect the echo box as outlined in subparagraph a above.

(2) The peak reading obtained on the echo box meter in subparagraph a above is a measure of the power output of the radar set.

(3) Record this reading to serve as a continual check on the system power output. If the crystal in the meter panel is changed or deteriorates, however, a new reference reading must be taken.

g. For Measuring Magnetron Frequency.

(1) Connect the echo box as outlined in subparagraph a above.

(2) Note the scale reading on the FREQUENCY CONTROL dial of the echo box obtained in subparagraph a above.

(3) This reading, when compared with a previous or subsequent reading, indicates the shift in frequency of the magnetron oscillator if a shift has occurred, or the change in frequency between the present and replaced magnetrons if a magnetron has been installed.

(4) Each FREQUENCY CONTROL dial scale division represents about 1 mc, the frequency increasing with larger scale numbers.

h. For System Line-up. If system performance is poor, or if the magnetron has been replaced, or if other elements of the receiver system have been changed, a realignment of the circuits should be made. Two methods are outlined below. The test equipment required for method 1 are Test Set TS-91/TPS-1 (including an adjustable echo box or ringing cavity, an output meter, and connecting cords) and a 10-db pad. The test equipment required for method 2 is that listed above for method 1 plus a second 10-db pad, the jack-ended connector furnished with Test Set TS-91/TPS-1, and the green cord of the radio set. An advantage of method 2 is that the test set meter can be located near the preamplifiers in tower section No. 4 while they are being tuned, whereas method 1 requires observation of the Class A oscilloscope screen on the indicator unit panel in tower section No. 2. Figure 69 represents the instruction sheet attached to the test set panel. Follow the procedure indicated below in its entirety to obtain the best line-up and therefore the best system performance in terms of increased range or signal-to-noise ratio.

(1) CHECKING OF VOLTAGES.

(*a*) With the radio set in operation, measure the a-c voltage at OUTLET, 115V, 400 ~, on the indicator unit panel with Test Set TS-96/TPS-1 (meter) and readjust at the power unit to 115 volts if necessary.

(*b*) Measure the d-c voltage from the AMP 1 jack on the r-f unit to ground. The voltage should be 1 volt. If it is not, turn the AMP 1 screw on the r-f unit with a screwdriver until the meter indicates 1 volt.

(*c*) Measure the d-c voltage from the AMP 2 jack on the r-f unit to ground. The voltage should be 1 volt. If it is not, turn the AMP 2 screw on the r-f unit with a screwdriver until the meter indicates 1 volt.

(*d*) Measure the d-c voltage from the MOD jack on the r-f unit to ground. The voltage should be 0.5 volt. If it is not, turn the MOD screw on the r-f unit with a screwdriver until the meter indicates 0.5 volt.

(2) SYSTEM LINE-UP, METHOD 1. The use of a mirror is suggested to permit the man

who does the tuning to observe the trace on the Class A oscilloscope.

(*a*) With the echo box connected to the probe jack as outlined in subparagraph a above, connect the T-R box output cable to the mixer input jack through one of the 10-db pads (fig. 72) which are clipped to the r-f unit panel above the T-R box (fig. 32). Check that the echo box is tuned to obtain a maximum ringtime, and during the following steps recheck that the echo box has remained tuned, following the procedure of subparagraph a above. Tune with the TUNING knob on the indicator unit panel to obtain maximum ringtime.

(*b*) Tune the T-R box to obtain maximum ringtime by loosening the left-hand clamping screw on the T-R box and turning the left-hand tuning screw slowly in or out. If the box is considerably off-tune, loosen both left- and right-hand clamping screws and turn out both left and right tuning screws. Observing for maximum ringtime, turn in the right-hand tuning screw until maximum ringtime is obtained. Unscrew the right-hand tuning screw two turns, and clamp. Then turn in the left-hand tuning screw to reobtain maximum ringtime and clamp it. Fine adjustments of tuning can be made subsequently by using the left-hand tuning screw. To facilitate accurate timing, observe any echo or range marker pip which falls on the sloping side of the ringtime image (fig. 71). Any slight change in ringtime will be plainly indicated by the rise and fall of point A.

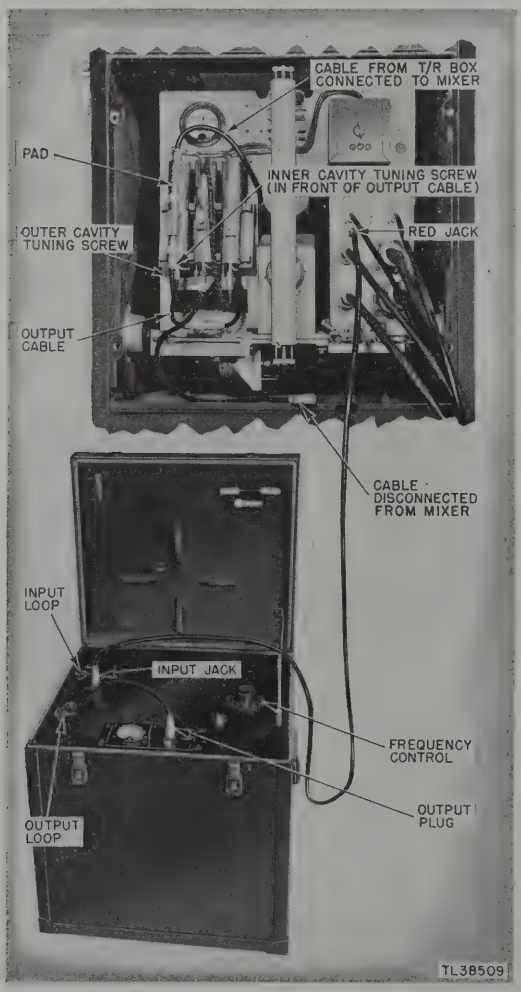


Figure 72. Echo box connections for adjustment of mixer.

(*c*) Tune the mixer input for maximum ringtime by rotating the outer cavity tuning screw. This screw is located at the bottom of the assembly to the left of the center line.

(*d*) Tune the beat oscillator by turning the TUNING knob on the indicator unit panel.

(*e*) Tune the mixer output circuit by turning with a screwdriver the slotted screw at the bottom of the mixer assembly until maximum ringtime is observed. Recheck the TUNING knob adjustment, and the mixer output circuit adjustment. If the TUNING knob adjustment made considerable change, it is advisable to repeat this step a third time.

(*f*) Insert preamplifier No. 2 between the T-R box and the 10-db pad at the mixer. Tune the preamplifier inner cavity, turning the inner cavity tuning screw as required; and then the outer cavity, turning the outer cavity tuning screw. Recheck the inner cavity tuning. Recheck the T-R box tuning. Retune the outer cavity for its final adjustment. Lock the cavity in position with the outer cavity clamping nut on the input jack assembly.

(*g*) Remove the 10-db pad and connect it at preamplifier No. 2 input. Connect in preamplifier No. 1 between the pad and the T-R box. Proceed as in step (*f*) above.

(*h*) Remove the pad from the circuit. Connect the parts in the usual operating manner; that is, the T-R box cord to the input of preamplifier No. 1, the output of preamplifier No. 1 to the input of preamplifier No. 2, the output of preamplifier No. 2 to the input of the mixer.

(*i*) Starting at the T-R box, make a complete recheck for maximum ringtime of the

tuning as follows. (Do not change the outer cavities of the preamplifiers.)

1. TUNING control on indicator unit panel.
2. Output circuit of the mixer.
3. Outer cavity of the mixer.
4. Inner cavity of preamplifier No. 2.
5. Inner cavity of preamplifier No. 1.
6. T-R box.

(*j*) Disconnect the echo box from the probe jack in the r-f unit.

(*k*) Occasionally additional improvement can be obtained by making a final check on the TUNING control using a marginal echo as an indicator. A marginal echo is one whose pip appears just out of the noise (grass) on the Class A oscilloscope.

(3) SYSTEM LINE-UP, METHOD 2.

(*a*) Perform steps (*a*) through (*e*) of method 1 (subpars. (2) (*a*) through (2) (*e*) above).

(*b*) Remove the meter panel from the echo box test set by loosening the four cowl fasteners which hold it. Set this panel in tower section No. 4 below the r-f unit. Connect the echo box OUTPUT PLUG to the jack-ended connector which is clipped to the cover of Test Set TS-91/TPS-1. Remove the green cord from the indicator unit panel and the r-f unit panel, and connect one end to the jack-ended connector. Connect the other end of the green cord to a 10-db pad. Set the OUTPUT LOOP of the echo box to position OUT. Connect the 10-db pad to the input of preamplifier No. 1. Connect the output cord of preamplifier No. 1 to a second 10-db pad. Connect the second pad to the METER JACK of the echo box meter. These connections are shown in figure 73.

(*c*) Adjust the INPUT LOOP and OUTPUT LOOP knobs on the echo box to obtain a meter reading of about half scale.

(*d*) Loosen the outer cavity clamping nut of preamplifier No. 1. Tune the inner cavity of preamplifier No. 1 by turning the inner cavity tuning screw to give a maximum reading on the meter; tune the outer cavity by turning the outer cavity tuning screw to give a maximum meter reading. Recheck the inner cavity tuning. Recheck the outer cavity tuning and tighten the clamping nut.

(*e*) Disconnect the cables from preamplifier No. 1 and connect them to preamplifier No. 2 (fig. 74) in the same way in which they were

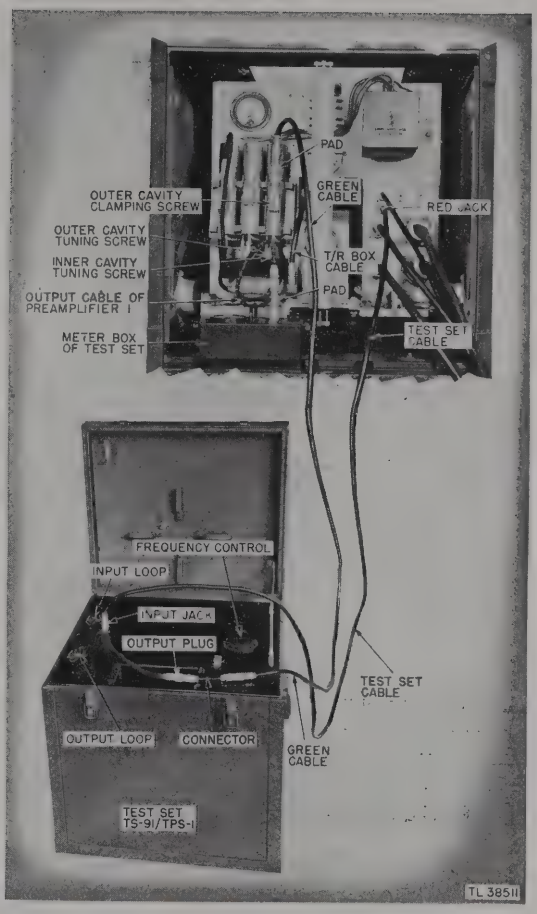


Figure 73. Echo box connections for adjustment of preamplifier No. 1.

connected to preamplifier No. 1. Repeat steps (*c*) and (*d*) on preamplifier No. 2.

(*f*) Disconnect the echo box and meter cables and remove the pad from the circuit. Connect the parts in the usual manner; that is, the T-R box cable to the input of preamplifier No. 1, the output of preamplifier No. 1 to the input of preamplifier No. 2, the output of preamplifier No. 2 to the input of the mixer. Replace the meter in the test set. Reconnect the green cable between the indicator unit and the r-f unit.

(*g*) Starting at the T-R box, make a complete recheck of the tuning as follows. (Do not change the outer cavities of the preamplifier.)

1. TUNING control on indicator unit panel.
2. Output circuit of the mixer.

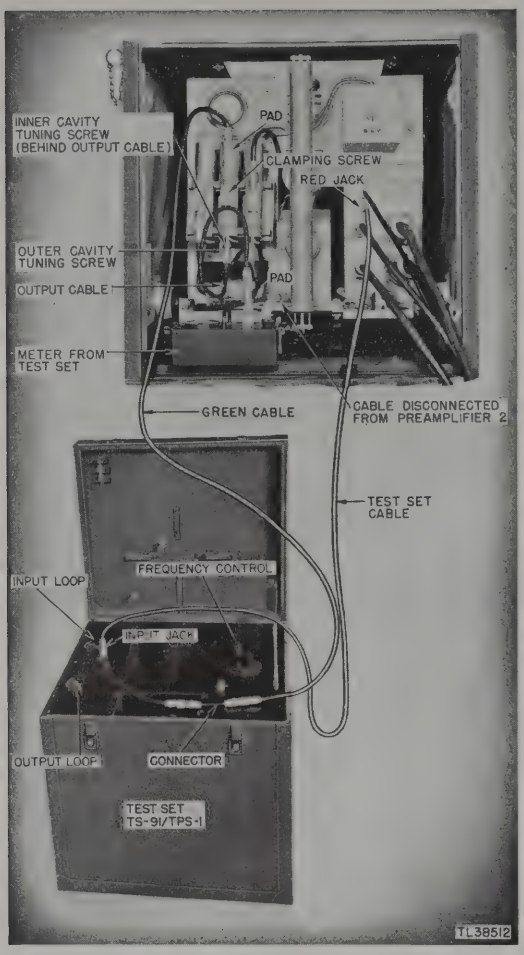


Figure 74. Echo box connections for adjustment of preamplifier No. 2.

3. Outer cavity of the mixer.
4. Inner cavity of preamplifier No. 2.
5. Inner cavity of preamplifier No. 1.
6. T-R box.

(*h*) Disconnect the echo box from the probe jack in the r-f unit.

(*i*) Occasionally additional improvement can be obtained by making a final check on the TUNING control using a marginal echo as an indicator. A marginal echo is one whose pip appears just out of the noise (grass) on the Class A oscilloscope.

i. Ringtime Measurement. The ringtime is the time in miles on the Class A oscilloscope from the beginning of the transmitted pulse to the point where the signal from the echo box fades into the noise level. The ringtime and power measurements are used to check performance as follows:

(1) Ringtime and power both low means that trouble exists in the transmitter or r-f systems, or both, but probably not in the receiver system.

(2) Erratic ringtime and power readings indicate transmitter or r-f system trouble, such as a faulty transmitter tube or loose r-f line joints.

(3) Maximum ringtime indicates that the T-R box is tuned properly.

j. Relation of Ringtime and Operating Range. When a radar system under test shows a ringtime less than normal it is an indication that the service range is below par. No very precise relation between loss of ringtime and loss of range can be given. The following tabulation, however, may be used as a rough guide:

Observed ringtime— percent of normal	*Operating range— percent of normal*
100	100
95	80
90	70
85	60
80	50
70	30
55	20
45	15

It will be seen that a small loss in ringtime represents a relatively great loss in effective range. *Proper operation therefore demands that ringtime be measured as carefully and accurately as possible.*

38. TEST SET TS-96/TPS-1 (MULTIRANGE METER).

a. General. This meter, Precision Apparatus Co., Model 856P, is a test meter for general checking purposes. It is stored on the tray in tower section No. 2.

b. Uses of the Multirange Meter. (1) Voltage checks at any test point mentioned in the trouble-shooting procedures of this manual.

(2) Voltage checks at any test point not mentioned but at which the normal voltage is *known* not to exceed the range of this meter.

(3) Resistance checks at any test point mentioned in the trouble-shooting procedures of this chapter.

SECTION III

TROUBLE SHOOTING BASED ON STARTING PROCEDURE

WARNING: *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this radio set. Do not place hands in any component with high voltage on. Do not make connections which will bring high voltages out to an exposed point. Make all tests with high voltage off. Always short high-voltage capacitors before touching them or their associated parts.*

39. REFERENCE DATA.

The following figures will be of value as references in trouble shooting by the use of the starting procedure:

a. Figure 9, Radio Set AN/TPS-1A, block diagram and control system circuits.

b. Figure 10, Control system, simplified schematic diagram.

c. Figure 11, Antenna Drive Unit C-14/TPS-1, schematic diagram.

d. Figure 12, Mechanical antenna controls, schematic diagram.

e. Figure 13, Location of control system parts.

f. Figure 14, Antenna Drive Unit C-14/TPS-1, partially disassembled, right side view.

g. Figure 29, Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

h. Figure 44, Indicator Unit ID-16/TPS-1A, front panel.

40. INTRODUCTION.

The analysis of trouble symptoms, and the trouble-shooting information which follows the analysis, have been prepared to aid the repairman in isolating and correcting such troubles as may occur, so that the set may be placed back in operation as quickly as possible. The best procedure for locating and isolating trouble is to start the set in logical steps and to watch carefully for the first appearance of an improper indication. In starting the set, follow the procedure given in paragraph 28 of TM 11-1347A. This section follows the starting-procedure sequence and presents the normal and abnormal indications for each step. The explanations of the abnormal indications will enable the operator, in most cases, to discover in which component the trouble has occurred, so that the faulty component may be repaired or replaced with minimum delay. If a replacement is not available, refer to the tests, procedures, and reference data given in the following sections of this chapter.

41. STARTING PROCEDURE, TROUBLE-SHOOTING CHART.

A. STEP 1. See that POWER and FAN switches on indicator unit are in off position and that SEARCH switch is at HAND (fig. 44).

B. STEP 2. Start the power unit.

NORMAL INDICATIONS: For normal and abnormal indications and corrective measures, see TM 11-933, Power Unit PU-6/TPS-1.

C. STEP 3. Throw POWER switch on indicator unit to ON position.

NORMAL INDICATIONS:
1. Blower motor in modulator unit starts operating and is audible.
2. Blower motor in r-f unit starts operating and is audible.
3. PPI dial lamps light.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. No normal indications present.	1*a*. Burned out fuse in the 115v a-c output line in power unit. *b*. No output from power unit. *c*. Safety switch in indicator unit not closed because indicator chassis not properly seated in its shock-mounted dust shield (tower section No. 2). *d*. Defective 115v a-c line in blue cable between power unit and modulator unit. *e*. Defective blue cable connection or receptacle. *f*. Broken connection or defective wiring cord (fig. 9). *g*. Broken or defective POWER switch on indicator unit. *h*. Defective orange cable between indicator unit and r-f unit. *i*. Defective orange cable connection or receptacle.
2. Neither blower operates, but dial lamps light.	2. Burned-out fuse 377 in indicator unit. This is fuse C on indicator unit front panel.
3. Blower in modulator unit does not operate, but other indications normal.	3*a*. No a-c input to blower. *b*. Broken or defective blower in modulator unit. *c*. Defective red cable between r-f unit and modulator unit. *d*. Defective red cable connection or receptacle. *e*. Broken connection or defective cord in modulator unit.
4. Blower in r-f unit does not operate, but other indications normal.	4*a*. Broken connection or defective cord in r-f unit blower circuit. *b*. No a-c input to blower. *c*. Broken or defective blower in r-f unit. See paragraph 59e for replacement of r-f unit blower assembly.
5. PPI lamps do not light, but other indications normal.	5. Burned-out fuse 375 in indicator unit. This is fuse A on indicator unit front panel.

D. STEP 4. Three minutes or more after POWER switch has been thrown to ON, press TRANSMITTER ON button on indicator unit for about 10 seconds (fig. 44).

NORMAL INDICATIONS:
1. Meter on r-f unit reads approximately 10 to 18 milliamperes.
2. Meter pointer is steady.
3. Sweep line appears on PPI scope, and can be adjusted for brightness by the PPI BRIGHTNESS control knob.
4. Sweep line appears on Class A oscilloscope, and can be adjusted for brightness by the CLASS A BRIGHTNESS control knob.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. No normal indications present.	1*a*. Poor connection of silver cable from modulator unit to r-f unit, or broken or defective silver cable. *b*. Safety switch (magnet) not closed because magnet not raised to its proper position. *c*. Burned-out fuse in 115v a-c output line in power unit. *d*. Burned-out fuse 378 in indicator unit. This is fuse D on front panel. *e*. No output from power unit. *f*. Safety switches in indicator unit (fig. 104) not closed because indicator chassis not properly seated in its shock-mounted dust shield (tower section No. 2). *g*. Defective blue cable between power unit and modulator unit. *h*. Defective blue cable connector or receptacle. *i*. Broken connection or defective wiring cord (fig. 9). *j*. Broken or defective POWER switch on indicator unit. *k*. Safety switch on modulator unit (fig. 23) not closed because rear door of modulator unit either open or not properly closed. *l*. Broken or defective safety switch (fig. 9) in modulator unit. *m*. Broken or defective transmitter control relay or relay contact points. *n*. Broken or defective overload relay in modulator unit causing relay to remain open. *o*. Broken or defective TRANSMITTER ON button. *p*. Defective autotransformer in r-f unit. *q*. See section V, Trouble Shooting in Transmitter System.
2. Meter on r-f unit does not read 10 to 18 milliamperes, but other indications normal.	2*a*. Broken connection or defective cord in meter circuit. *b*. Broken or defective meter. *c*. See section V, Trouble Shooting in Transmitter System.
3. Plate current meter reading is normal, but no sweep line appears on either PPI or Class A oscilloscope.	3*a*. Burned-out fuse 375 or 376 in indicator unit. These are fuses A and B respectively on the indicator unit panel. *b*. Defective orange cable connector or receptacle. *c*. Defective orange cable between indicator unit and r-f unit. *d*. Broken connection or defective wiring cord in triggering pulse circuit. See section V, Trouble Shooting in Transmitter System. *e*. See section VIII, Trouble Shooting in Indicator System.
4. No sweep line appears on PPI scope, but other indications normal.	4*a*. Improper adjustment of PPI BRIGHTNESS control on indicator unit panel (fig. 44). *b*. See section VIII, Trouble Shooting in Indicator System.
5. No sweep line appears on Class A oscilloscope, but other indications normal.	5*a*. Improper adjustment of CLASS A BRIGHTNESS control on indicator unit panel. *b*. See section VIII, Trouble Shooting in Indicator System.
6. Normal meter reading shows temporarily but drops to zero.	6*a*. Starting cold, there may be "kick-offs" for a number of minutes with the meter reading dropping to zero. Press the TRANSMITTER ON button again in that event, after each

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
6. Normal meter reading shows temporarily but drops to zero (contd).	kick-off. Occasional kick-offs may occur even after the set has been operating for some time. *b.* Overload in the transmitter system causing overload relay in modulator unit to open. See section V, Trouble Shooting in Transmitter System.
7. Meter pointer is unsteady.	7*a.* Poor connection in meter circuit (fig. 31). *b.* Broken or defective meter.

E. STEP 5. Check voltage of power unit and adjust to 115v if necessary.

NORMAL INDICATION: Output from power unit can be adjusted to 115v.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Power unit cannot be adjusted to 115v.	1*a.* Defective leads on meter used to check power unit output voltage. *b.* Poor connection of leads between checking meter and power unit. *c.* Broken or defective meter used in checking power unit. *d.* See TM 11-933, Power Unit PU-6/TPS-1.

F. STEP 6. Throw SEARCH switch on indicator unit (fig. 44) to MOTOR position.

NORMAL INDICATIONS:
1. Antenna rotates at a speed of about 12 rpm.
2. Handwheel rotates.
3. Sweep line on PPI scope rotates in synchronism with antenna.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Antenna does not rotate.	1*a.* Broken or loose antenna drive belt (fig. 14). *b.* Defective orange cable connector or receptacle. *c.* Defective orange cable between indicator unit and r-f unit. *d.* Defective white cable connector or receptacle. *e.* Defective white cable between r-f unit and antenna drive unit. *f.* Broken connection or defective wiring cord (fig. 9). *g.* Broken or defective relay 386 in indicator unit, or relay contact points. *h.* Broken or defective relay 506 in antenna drive unit, or relay contact points. *i.* Broken or defective SEARCH switch on indicator unit. *j.* Broken or defective antenna drive motor. See paragraph 45f for replacement of antenna drive motor. *k.* Broken or defective magnetic clutch. See paragraph 45a for replacement of magnetic clutch. *l.* Broken or defective gear or drive mechanism. See paragraph 45c for replacement of antenna drive gearbox assembly.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
2. Antenna rotates, but neither handwheel nor sweep line on PPI oscilloscope rotate.	2*a*. Vertical drive downshaft not properly fitted or connected. *b*. Broken or defective vertical drive downshaft or downshaft socket ends. *c*. Broken or defective gear or drive mechanism in handwheel gearbox assembly. See paragraph 45d for replacement of handwheel gearbox assembly.
3. Sweep line on PPI oscilloscope does not rotate in synchronism with antenna, other indications normal.	3*a*. Flexible shaft from handwheel gearbox to indicator unit not properly fitted or connected. *b*. Broken or defective flexible shaft. *c*. Broken or defective AZIMUTH control (fig. 44), causing disengagement of PPI tube gear train. See paragraph 71e for replacement of PPI tube gear train assembly. *d*. Broken or defective PPI tube drive mechanism or gear train assembly. See paragraph 71e for replacement of PPI tube gear train assembly. *e*. Deflection coil assembly of PPI scope improperly placed or connected. See paragraph 71d for replacement of PPI oscilloscope deflection coil assembly.

G. STEP 7. Turn RANGE switches on indicator unit to 20 (miles).

NORMAL INDICATIONS:
1. Normal appearance of sweep line and echoes on Class A oscilloscope.
2. Normal appearance of rotating sweep line on PPI oscilloscope with corresponding normal echoes for the 20-mile range at that particular location of the set.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Any abnormal appearance of sweep line or echoes on Class A or PPI oscilloscope.	1. See section VII, Trouble Shooting in Receiver System, or section VIII, Trouble Shooting in Indicator System.

H. STEP 8. Press RANGE MARKER buttons (fig. 44) for both Class A and PPI oscilloscopes.

NORMAL INDICATIONS:
1. Two range marker pips are superimposed on the Class A oscilloscope sweep line (fig. 7).
2. Two range marker circles appear on the PPI oscilloscope (fig. 8).

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Range marker pips do not appear or do not appear normal on Class A oscilloscope.	1. See section VIII, Trouble Shooting in Indicator System.
2. Range marker circles do not appear or do not appear normal on the PPI oscilloscope.	2. See section VIII, Trouble Shooting in Indicator System.

I. STEP 9. Turn the Class A RANGE switch to 100 miles and PPI scope RANGE switch to 60 miles (fig. 44).

NORMAL INDICATIONS:
1. Normal appearance of sweep line and echoes on the Class A oscilloscope.
2. Normal appearance of rotating sweep line on PPI oscilloscope with corresponding normal echoes for the 60-mile range at that particular location of the set.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Any abnormal appearance of sweep line or echoes on Class A oscilloscope or PPI oscilloscope.	1. See section VII, Trouble Shooting in Receiver System, or section VIII, Trouble Shooting in Indicator System.

J. STEP 10. Press RANGE MARKER buttons for both Class A and PPI oscilloscopes.

NORMAL INDICATIONS:
1. Ten range marker pips are superimposed on the Class A oscilloscope sweep line.
2. Six range marker circles appear on the PPI oscilloscope.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Range marker pips do not appear or do not appear normal on Class A oscilloscope.	1. See section VIII, Trouble Shooting in Indicator System.
2. Range marker circles do not appear or do not appear normal on the PPI oscilloscope.	2. See section VIII, Trouble Shooting in Indicator System.

K. STEP 11. If ventilation is required, throw FAN switch on indicator unit to ON. Adjust ventilator shutter to ventilate tent properly.

NORMAL INDICATIONS:
1. Blower motor of tent ventilating unit starts operating and is audible.
2. Air is exhausted from ventilator shutter when it is opened.

ABNORMAL INDICATION	PROBABLE LOCATION OF FAULT
1. Blower motor does not operate.	1*a*. Broken or faulty FAN switch on indicator unit (fig. 44). *b*. Broken or faulty connection in blower motor circuit (fig. 9). *c*. Broken or defective ventilating unit. See paragraph 45e for replacement of tent ventilating assembly.
2. Air is not being exhausted from ventilator shutter.	2*a*. Be sure shutter is open. *b*. Look into the ventilating unit to *see* if blower is operating. *Do not put fingers into blower.*

SECTION IV

TROUBLE SHOOTING IN CONTROL SYSTEM

WARNING: *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this radio set. Do not put hands or arms inside any component with high voltage on. Do not make any connections into this system which will bring high voltage out to an exposed point. Make all tests with high voltage off. Always short high-voltage capacitors before touching them or their associated parts.*

42. REFERENCE DATA.

The following figures are included to aid maintenance personnel engaged in trouble shooting the control system. See also references in paragraph 39.

a. Figure 9, Radio Set AN/TPS-1A, block diagram and control system circuits.

b. Figure 10, Control system, simplified schematic diagram.

c. Figure 11, Antenna Drive Control Unit C-14/TPS-1, schematic diagram.

d. Figure 12, Mechanical antenna controls, schematic diagram.

e. Figure 13, Location of control system parts.

f. Figure 14, Antenna Drive Unit C-14/TPS-1, partially disassembled, right side view.

g. Figure 15, Tower section No. 3, showing Control Unit C-13/TPS-1 with magnet not raised.

h. Figure 44, Indicator Unit ID-16/TPS-1A, front panel.

i. Figure 59, Indicator Unit ID-16/TPS-1A, schematic diagram complete except for rectifier circuits and i-f amplifier assembly.

j. Figure 75, Antenna Drive Unit C-14/TPS-1, removal of gearbox.

k. Figure 76, Parts removed from drive unit in removal of gearbox.

l. Figure 77, Antenna drive motor disassembled.

m. Figure 78, Antenna Drive Unit C-14/TPS-1, front view.

n. Figure 79, Antenna Drive Unit C-14/TPS-1, wiring diagram.

43. INTRODUCTION.

The theory of operation of the circuits of the control system (fig. 9) has been explained in chapter 1, section II. In addition, the section on trouble shooting based on the starting procedure covers a majority of possible troubles in control system and gives the probable location of the fault. This section (section IV) explains the location of troubles which are not covered by the various abnormal-condition symptoms in section III, Trouble Shooting Based on Starting Procedure.

44. CONTROL SYSTEM, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

Convenience OUTLET, 115V, 400~, on front of indicator unit (fig. 44) is not "hot", although blowers in tower section No. 1 and tower section No. 4 operate.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Convenience outlet circuit of indicator unit.	1*a*. Check for broken, loose, or shorted connection in convenience outlet circuit of indicator unit (fig. 59). *b*. Check OUTLET, 115V, 400~ part 379 on panel of indicator unit.

B. SYMPTOM:

Blower motor 700 in indicator unit does not operate when indicator unit is warm, although blowers in tower section No. 1 and tower section No. 4 operate.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Blower motor 700 circuit of indicator unit.	1*a*. Check for broken, loose, or shorted connection in blower motor 700 circuit of indicator unit (fig. 57). *b*. Check thermostat 702. Replace if broken or defective. *c*. Check blower motor 700 of indicator unit. Replace if defective.

C. SYMPTOM:

One or all of the four azimuth dial screen lights (397-1, -2, -3, and -4) do not light or their brightness cannot be controlled by SCREEN LIGHT control 301 on front of indicator unit (fig. 44), although sweep line shows on Class A oscilloscope.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Azimuth dial screen lights circuit of indicator unit.	1*a*. Check for faulty lamp or lamps. Replace if broken or defective. See subparagraph 71b for procedure in replacing lamps. *b*. Check for broken, loose, or shorted connection in circuits of azimuth dial screen lights (fig. 57). *c*. Check potentiometer 301. Replace if faulty. *d*. Check secondary of transformer 363.

D. SYMPTOM:

No input to a particular circuit.

PROBABLE LOCATION OF FAULT	PROCEDURE
	NOTE: Fuses are used to protect the equipment in case of an overload such as is caused by a shorted condition. Most of the major circuits include fuse protection. The following is the general procedure in the event of a blown fuse.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Blown fuse.	1*a*. Try replacing fuse and see if second fuse also blows out. *b*. If second fuse blows, study schematic diagrams of indicator unit (figs. 59 and 57) to determine those circuits to which power is supplied through fuse which has blown. *c*. Inspect wiring and parts included in the circuit for evidence of burning, shorted wires, soldered connections, frayed insulation, and similar faults. *d*. Check circuit by means of resistance tests. *e*. Check for *loose connections* as well as shorts.

45. REPLACEMENT OF PARTS.

a. Replacement of Magnetic Clutch (fig. 14). (1) Remove the brush holder by removing the four screws attaching it to the clutch housing.

(2) Take out the four screws on the flange of the magnetic clutch (fig. 76). Push the housing, still resting on its shelf, to one side (toward the ventilator). The magnetic clutch is now fully exposed.

(3) Drive out the taper pin on the shaft at top of the magnetic clutch. The clutch, attached to the pulley by three groove pins, is a force fit on the shaft; clutch and pulley come off as a unit. Separate the clutch and pulley by driving out the three groove pins.

(4) Replace in the reverse order.

b. Replacement of Drive Belt (fig. 14). (1) If the position of the brush holder housing on the clutch housing is not already marked, mark it. Remove the brush holder by removing the four screws attaching it to clutch housing.

(2) Remove the magnetic clutch housing by taking out the four flange screws. Lift the housing up and push it to one side (toward the ventilator).

(3) Remove the screws holding the cover on the gearbox side of the motor drive pulley housing (fig. 14).

(4) Loosen the four holding bolts on the antenna drive motor flange (fig. 75) and reduce the belt tension by sliding the motor along the slots in the bottom of the housing in the direction of the gearbox.

(5) Hold the belt a few inches from the motor drive pulley and push it toward the motor while sidetracking the belt out of the pulley groove, thus removing the belt.

(6) Pull freed belt over magnetic clutch housing.

(7) Replace belt and reassemble by reversing the order of the removal steps above.

c. Replacement of Antenna Drive Gearbox Assembly (fig. 75). (1) Remove the brush holder by removing the four screws attaching it to the clutch housing.

(2) Take out the four screws on the flange of the magnetic clutch housing. Push the housing, still resting on its shelf, to one side (toward the ventilator). Remove the housing.

(3) Remove the driving belt from the gearbox pulley by riding it over the side of the pulley.

(4) Unscrew and remove the clamp beneath the gearbox (figs. 75 and 76).

(5) With gearbox thus free, pull out the pin locking the gearbox in position.

(6) Lift up the entire gearbox unit and remove it.

(7) Replace by reversing the order of the removal steps above.

d. Replacement of Handwheel Gearbox Assembly (fig. 15). (1) Remove the handwheel. Remove the antenna drive downshaft at the top of the gearbox.

(2) Disconnect the flexible shaft at the bottom of the gearbox.

(3) Remove the spring pin and the bolt holding the gearbox to the frame.

(4) To install the gearbox, place it in operating position, insert the bolt and spring pin, connect the flexible shaft to the bottom of the box, install antenna drive downshaft, and fasten the handwheel to the handwheel shaft on the front of the box.

e. Replacement of Tent Ventilating Assembly (fig. 78). (1) Collapse the tent on the ventilator outlet side. Use the antenna packing case to climb to the outlet.

(2) Lift the outlet cover to the wide-open position and take off the six machine screws holding the ventilator in the plywood opening.

(3) Unscrew the male connecting plug from

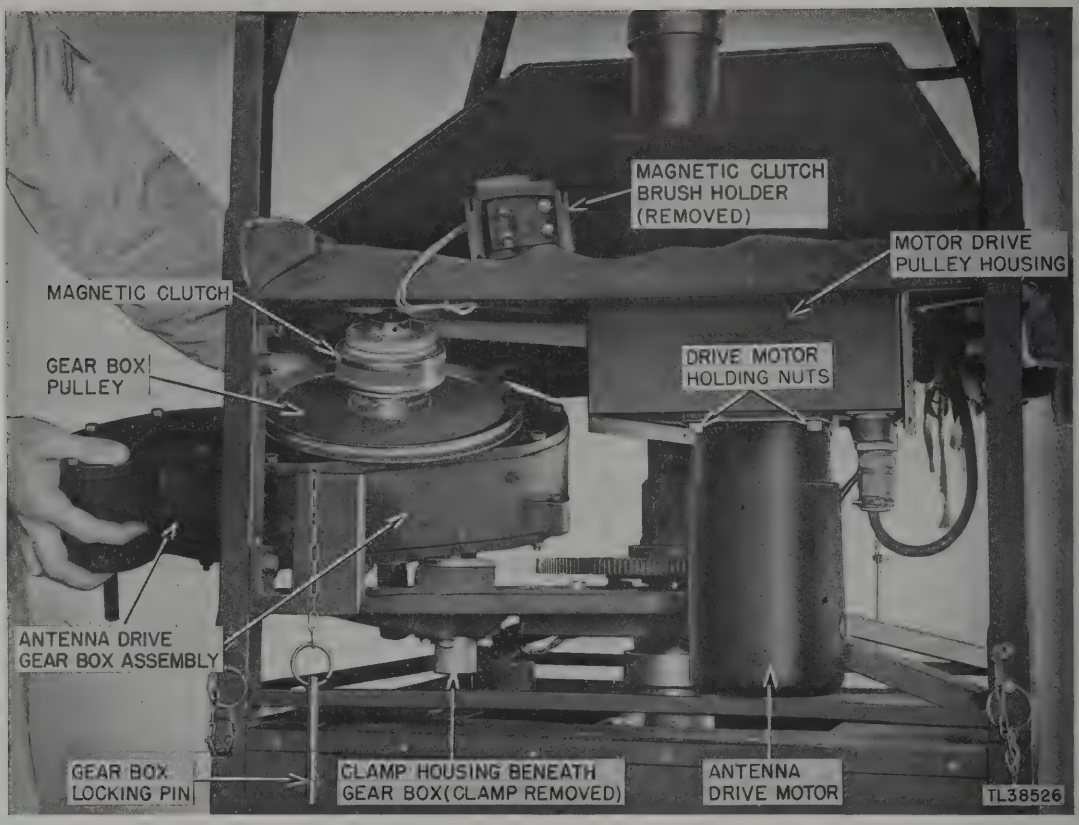


Figure 75. Antenna Drive Unit C-14/TPS-1, removal of gearbox.

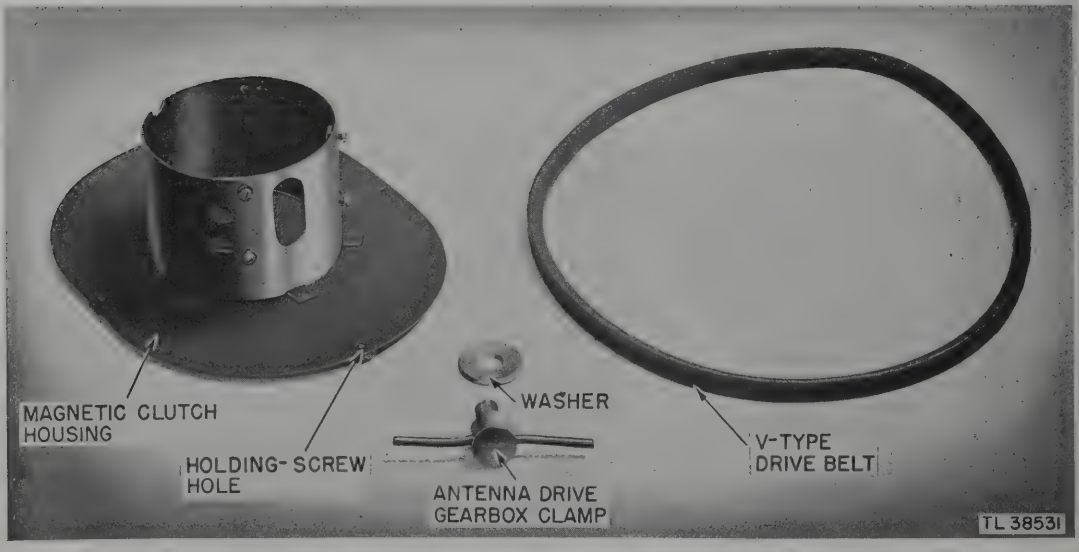


Figure 76. Parts removed from drive unit in removal of gearbox.

the ventilator motor, at the connector to the right of the antenna drive motor at the bottom of the drive pulley housing.

(4) Pull out the entire ventilating unit.

(5) Replace by reversing the order of the removal steps above.

f. Replacement of Antenna Drive Motor (fig. 14). This motor is located below the drive pulley housing.

(1) Remove the cover on the gearbox side of the motor drive pulley housing (fig. 14).

(2) Loosen the four motor mounting bolts; reduce the belt tension by sliding the bolts in the slots toward the gearbox; roll off the belt from the drive pulley.

(3) Detach the two small wires, which lead from the motor (through the grommet) into the drive pulley housing, from their connections to the relay mounted in the housing at the far end from the motor. (In an emergency these wires could be cut after marking identification color for correct splicing.)

(4) Remove the four motor mounting bolts. The entire motor and pulley drops down and is now easily accessible for disassembly of the motor (fig. 77) or repair or replacement of a motor part.

(5) Replace by reversing the order of the removal steps above. Be sure to have a clean surface on ground terminal under one of the mounting bolts.

46. TESTING OF COMPONENTS.

a. General Information. The following tests can be used to check the circuits in which trouble may cause operation of the overload relay in the control system. Radio-Frequency Unit RF-1/TPS-1 needs to be associated with a

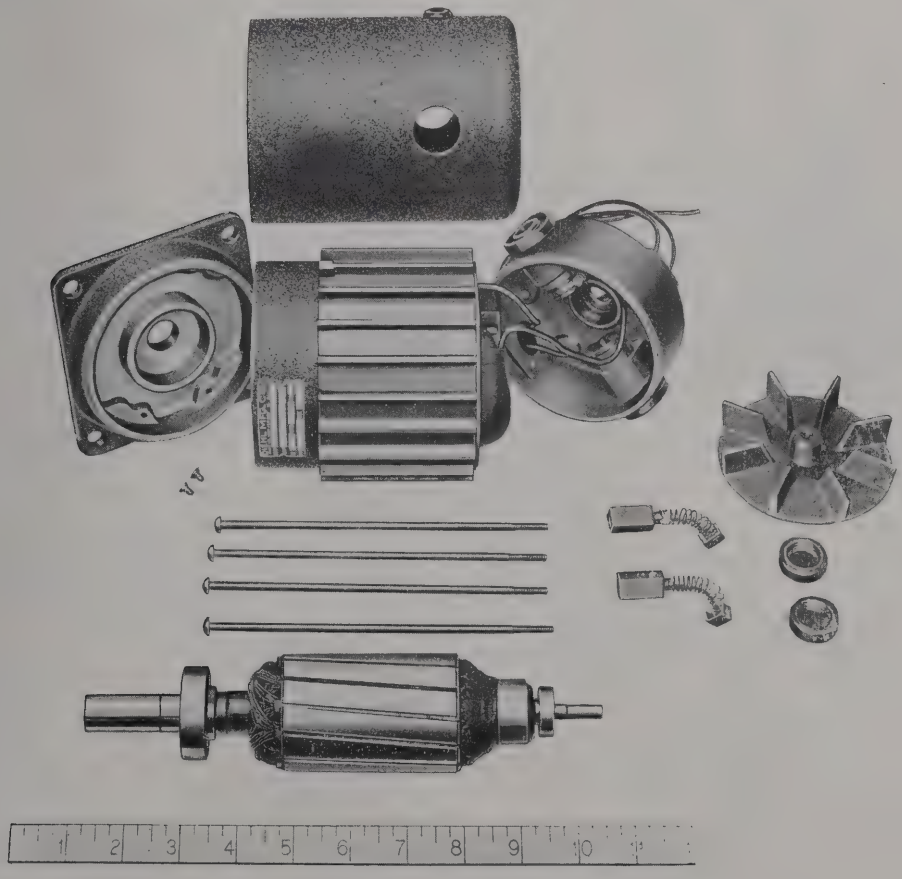


Figure 77. Antenna drive motor, disassembled.

Modulator Unit MD-2/TPS-1, an Indicator Unit ID-16/TPS-1A, and a Control Unit C-13/TPS-1 for these tests. In general it is desirable not to erect the units as a tower. Apparatus designations in general are stamped on or near the part under discussion. Also check against the appropriate schematic or wiring diagram.

b. Test Equipment. (1) The following equipment and facilities are required to perform the test described below. Information on special test equipment can be obtained from the handbooks describing such equipment.

(*a*) Power supply: 115 volts, 400 cycles alternating current, 1,250 watts; and 27 volts direct current, 300 watts.

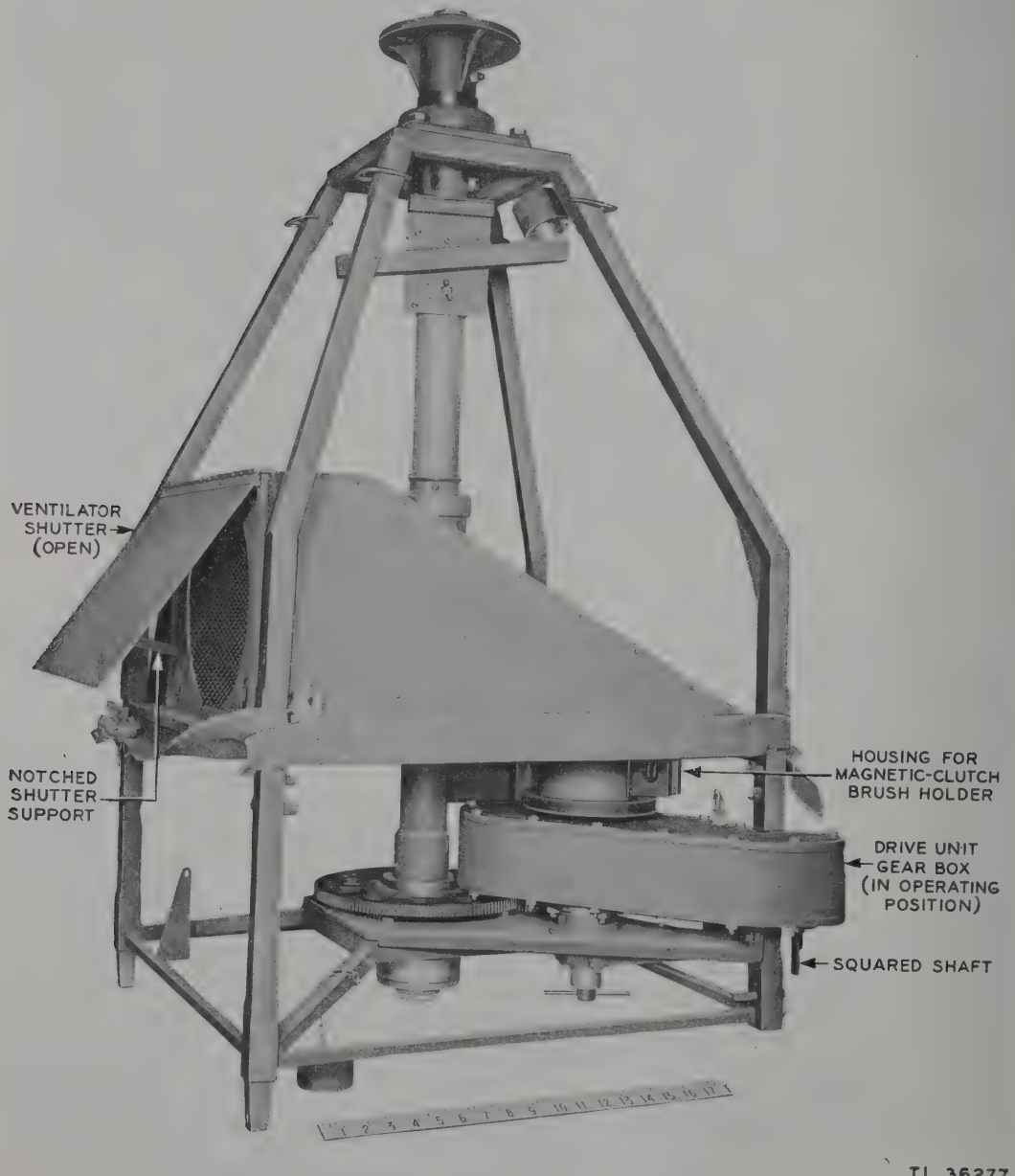


Figure 78. Antenna Drive Unit C-14/TPS-1, front view.

(*b*) Test Unit TS-104/TPM-1.

(*c*) Line Monitor TS-106/TPM-1.

(*d*) Voltage Divider TS-98/AP.

(*e*) Electrodynamometer type voltmeter, 400 cycles, range to 150 volts.

(2) In addition to the above items of test equipment, the following parts of Radio Set AN/TPS-1A should be available. These may be parts of the same set as the unit under test, or depot spares. They should be in good operating condition.

(*a*) Set of connecting cords for Radio Set AN/TPS-1A, as listed in table I (par. 2).

(*b*) Indicator Unit ID-16/TPS-1A, for use in tests on the modulator unit.

c. Checking Operation of Overload Circuits. (1) Remove the oil unit from the modulator, which has previously been removed from tower section No. 1.

(2) Make the following connections:

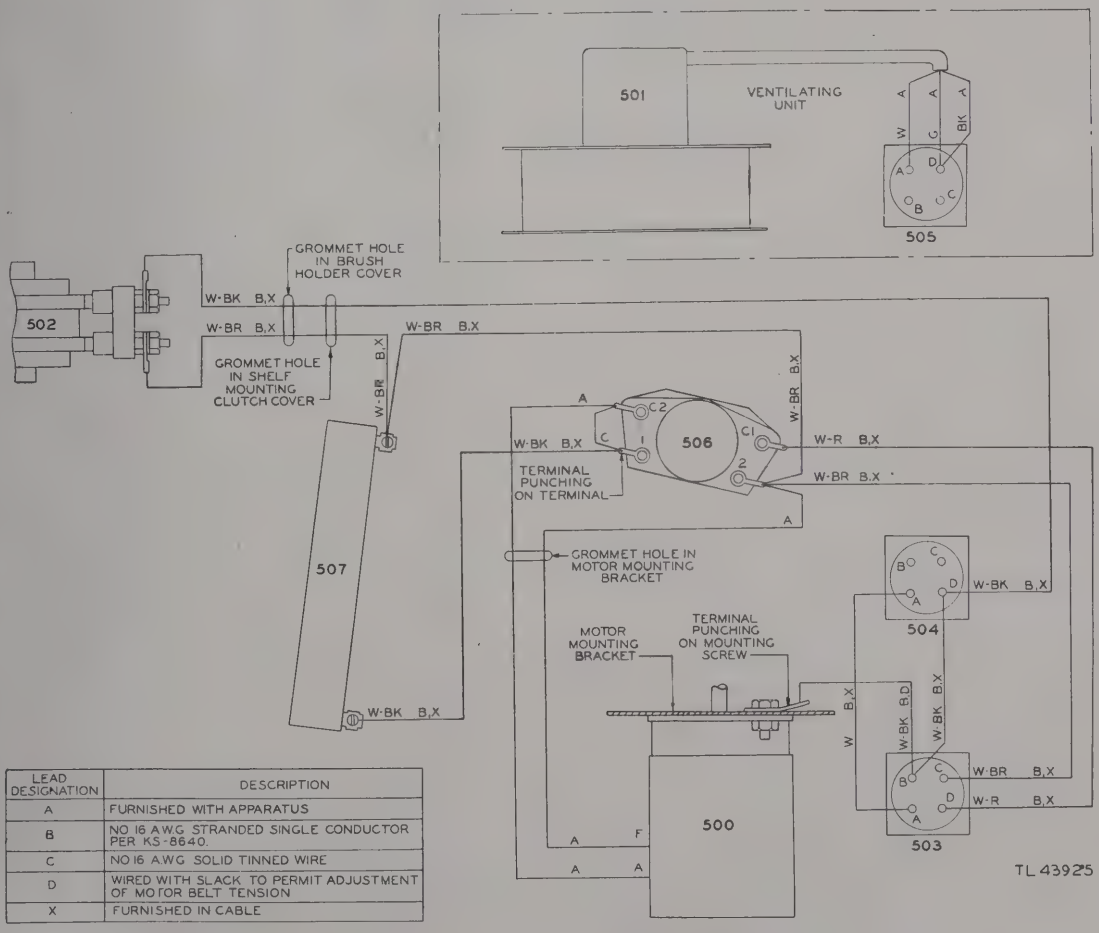
(*a*) From Line Monitor TS-106/TPM-1 output to the indicator unit GENERATOR connector.

(*b*) From the C RF UNIT connector of the indicator unit to the INDICATOR connector of Test Unit TS-104/TPM-1.

(*c*) From the MODULATOR connector of the test unit to the red connector of the modulator.

(3) Turn the PULSE switch of the test unit to OFF and the variac of the test unit to the zero voltage position.

(4) Throw the 115 VOLTS switch on the line monitor to the OFF position.



LEAD DESIGNATION	DESCRIPTION
A	FURNISHED WITH APPARATUS
B	NO 16 A.W.G. STRANDED SINGLE CONDUCTOR PER KS-8640.
C	NO 16 A.W.G. SOLID TINNED WIRE
D	WIRED WITH SLACK TO PERMIT ADJUSTMENT OF MOTOR BELT TENSION
X	FURNISHED IN CABLE

Figure 79. Antenna Drive Unit C-14/TPS-1, wiring diagram.

(5) Throw the POWER switch of the indicator unit to ON.
(6) Hold the TRANSMITTER ON button of the indicator unit down and check that relay 387 in the indicator unit operates. Release the TRANSMITTER ON button. Relay 387 in the indicator unit should remain closed.
(7) Operate manually overload relay 151 in the air unit and check that relay 387 in the indicator unit releases.
(8) Operate the TRANSMITTER OFF button.
(9) Place Voltage Divider TS-98/AP over the banana plugs of the air unit.
(10) Operate the 115 VOLTS switch of the line monitor to ON.
(11) After a short warm-up period, operate the TRANSMITTER ON button. Adjust the line voltage at Test Unit TS-104/TPM-1 to 115 volts, using the 400-cycle voltmeter.
(12) Check that the filaments light in the air unit vacuum tubes 160, 161, 162 and 106-3.
(13) Check that relay 387 in the indicator unit operates and locks up.
(14) Operate manually overload relay 151 in the air unit and check that relay 387 releases. The filament of tube 106-3 should go out.

CAUTION: *HIGH VOLTAGES ARE PRESENT IN THIS CIRCUIT. WHEN OPERATING THIS RELAY, DO NOT CONTACT ANY PARTS WHICH CARRY HIGH VOLTAGES.*

SECTION V

TROUBLE SHOOTING IN TRANSMITTER SYSTEM

WARNING: *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this system. Do not put hands or arms within the modulator unit or any of the high-voltage connections between the modulator unit and the transmitter tube while the high voltage is on. Do not make any connections which will bring high voltage to an exposed point. Except on specific output tests, make all tests with the high voltage off. Always short out high-voltage capacitors before touching them or their associated circuits.*

47. REFERENCE DATA.

The following figures are provided to assist maintenance personnel in trouble shooting in the transmitter system.

a. Figure 16, Transmitter system, simplified block diagram.

b. Figure 17, Transmitter system, complete block diagram.

c. Figure 18, Modulator Unit MD-2/TPS-1, front oblique view.

d. Figure 19, Modulator Unit MD-2/TPS-1, oil unit removed to show air unit.

e. Figure 20, Modulator Unit MD-2/TPS-1, cover removed to show vacuum tube compartment of oil unit.

f. Figure 21, Modulator Unit MD-2/TPS-1, oil unit.

g. Figure 22, Modulator Unit MD-2/TPS-1, complete schematic diagram.

h. Figure 23, Modulator Unit MD-2/TPS-1, rear view showing vacuum tube compartment.

i. Figure 24, Modulator Unit MD-2/TPS-1, simplified schematic diagram.

j. Figure 25, Radio-Frequency Unit RF-1/TPS-1, rear view.

k. Figure 29, Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

l. Figure 44, Indicator Unit ID-16/TPS-1A, front panel.

m. Figure 59, Indicator Unit ID-16/TPS-1A, schematic diagram complete except for rectifier circuits and i-f amplifier assembly.

n. Figure 65, Resistor color code.

o. Figure 68, Capacitor color code.

p. Figure 69, Test Set TS-91/TPS-1 (echo box), instruction sheet.

q. Figure 70, Echo box connections for frequency and power measurements and T-R box adjustment.

r. Figure 71, Echo box ringtime on Class A oscilloscope.

s. Figure 80, Oil level chart for modulator unit.

t. Figure 81, Measuring oil, using thermometer, pipette, and scale.

u. Figure 82, Oil unit, expansion chamber bladders.

v. Figure 83, Inserting new bladder in modulator oil unit.

w. Figure 84, Unscrewing magnetron clamping ring.

x. Figure 85, Removing magnetron.

y. Figure 86, Transmitter system and r-f system test waveforms.

z. Figure 87, Modulator Unit MD-2/TPS-1, air unit resistances.

aa. Figure 88, Modulator Unit MD-2/TPS-1, oil unit resistances.

bb. Figure 89, Modulator Unit MD-2/TPS-1, air unit wiring diagram.

cc. Figure 90, Modulator Unit MD-2/TPS-1, oil unit wiring diagram.

dd. Figure 91, Radio-Frequency Unit RF-1/TPS-1, wiring diagram.

48. INTRODUCTION.

It is assumed that the trouble has been localized to the transmitter system from the starting-procedure indications. In other words, indications are all normal up to the point at which the TRANSMITTER ON button is pressed. An idea of the cause of a fault may often be obtained by noting what abnormal indications appear when the TRANSMITTER ON button, which starts the operation of the transmitter system, is pressed. Note especially the reading on the plate current meter.

49. BEHAVIOR ANALYSIS.

Normally the transmitter system is placed in operation when the TRANSMITTER ON button on the indicator unit is pressed. The normal indications obtained when this button is pressed are discussed in section III, Trouble Shooting Based on Starting Procedure. Often when failure occurs in the transmitter system, the indications obtained when the TRANSMITTER ON button is pressed may be used to advantage.

a. No Normal Indications. In the event no normal indications are present when the TRANSMITTER ON button is pressed, the trouble is very probably in the control system or the silver cable (see section III, Trouble Shooting Based on Starting Procedure), but the trouble might possibly be in the modulator unit. This possibility is covered in symptom A, fault No. 3, of this section.

b. Overload in System. When normal indications appear momentarily, but disappear immediately after the TRANSMITTER ON button is pressed, the trouble may be an overload in the transmitter system. Relay 151 in the modulator unit is a direct current overload relay for protection of the high-voltage rectifier circuit in the modulator unit. An excess of current in this circuit causes the relay to open, removing power from the transmitter control relay which then opens and removes power from the high-voltage rectifiers in the modulator unit. In this case, since the balance of the transmitter system is the load for this rectifier, the trouble has been isolated to any condition which would cause an overload, such as a shorted connection or part, gassy transmitter tube, shorted transformer winding, or loss of gauss in the magnet for the transmitter tube. A simple way of testing for an overload is to press the TRANSMITTER ON button for several seconds, but no longer. If an overload exists, the relay will continue to open and close as long as the finger is held on the TRANSMITTER ON button.

c. Low Rectifier and Transmitter Current. When the TRANSMITTER ON button is pressed and the plate current meter (on r-f unit) indicates low transmitter current (less than 10 milliamperes), the trouble may usually be traced to low supply voltage, to the high-voltage rectifier in the modulator unit, poor rectifier tubes, or some other abnormal condition in the transmitter system. The plate current meter may be defective.

d. High Rectifier and Transmitter Current. When the plate current meter reading is high (more than 18 milliamperes) but not sufficient to cause operation of the overload relay, the trouble is similar to that which exists in case of an overload which actuates the overload relay.

e. Low Power Output. The output power of the transmitter system, after passing through the r-f plumbing, is radiated into space by the antenna. The procedure for the measurement of relative power output by means of the echo box are explained in paragraph 37f.

50. RESISTANCE CHARTS.

Resistance charts showing normal values of resistance in the transmitter system are given in this section (figs. 87 and 88).

51. TRANSMITTER SYSTEM, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

No reading on plate current meter and no sweep lines on either the PPI or Class A oscilloscope.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Control system.	1. See section III, Trouble Shooting Based on Starting Procedure, step 4, abnormal indication No. 1.
2. Input transformer in r-f unit (fig. 31).	2*a*. Turn off all power. Make continuity checks across windings of the input transformer, using schematic diagram. *b*. Replace transformer if defective.
3. Modulator unit.	3*a*. Visually inspect the tubes in the air unit by opening the door in the rear of the modulator unit (fig. 23), pressing safety switch 157 with the finger or nonmetallic handle of a tool, and observing the filaments of all the tubes. *b*. If tested tubes are available, change tubes in the air unit at this time, even though all filaments appear normal. If trouble is still present, proceed to next step. *c*. Replace oil unit of modulator (par. 53a) if a tested oil unit is available; if not, proceed to the next step. *d*. Examine the air unit for obvious troubles, such as loose or broken tubes, wires disconnected from tube caps, broken wires, etc. *e*. If a suitable oscilloscope and voltage divider are available, proceed with the following steps; if not, and the above tests have not located the trouble, replace the entire modulator unit. *f*. Test the air unit by using the power cable and the trigger cable of the system. A high-impedance scope is used. A voltage divider (TS-98/AP or equivalent) must be used to provide a termination for the network in the air unit, and to permit observation of the air unit output pulse. A suitable termination may be made by connecting an 800-ohm, 1-watt resistor in series with a blocking capacitor of approximately 0.03 mf, 600v, between banana plug No. 1 and ground. The capacitor should be on the banana-plug side of the combination. The scope is connected between ground and approximately a 5-ohm tap. *g*. If a pulse is observed, then the oil unit is at fault, provided that the following voltages appear across the banana terminals of the air unit.

Terminal No.	*Voltage*
1	—650 to —700
2	1175 to 1350
3	0
4	27 a-c, 400
5	a-c common
6	115 a-c, 400
7	. . . . .
8	115 a-c, 400

See paragraph 54c (1) for procedure in measuring air unit voltages. Procedure for checking the oil unit is given in *j* below.

PROBABLE LOCATION OF FAULT	PROCEDURE
3. Modulator unit (contd).	*h.* If no pulse is observed in *g*, the air unit is faulty and the following socket terminal voltages should be checked.

Term. No.	*Tube 6AG7 socket x101-1*	*Tube 829 socket x102*
1	0	0
2	0	—135v d-c
3	8.3v d-c	+800v d-c
4	13.0v d-c	0.5v d-c
5	8.3v d-c	6.3v a-c
6	65.0v d-c	—135v d-c
7	6.3v a-c	0
8	75.0v d-c	—

i. In most instances, the above information is sufficient to show up any faulty operation. It is necessary for the observer to correlate the discrepancy with the modulator schematic diagram and to make a diagnosis with such available information. On the rare occasions when no discrepancy appears after the above procedure has been followed, it is necessary to use a scope and follow the trigger into the multivibrator circuit until the point of elimination is found; reference to the schematic diagram at this point will give the observer the necessary information to make a diagnosis and repair the trouble or replace the defective component.

j. If it is determined that the oil unit is faulty, make the following continuity measurements before opening the vacuum tube compartment.

NOTE: Ground is also banana jack 3.

Between banana jacks:

1 and 2 — open
1 and ground — open
2 and ground — open
3 and 4 — 0 ohms
5 and 6 — 1 ohm
5 and ground — open
6 and ground — open
8 and ground — open
5 and 8 — 1 ohm
6 and 8 — 1 ohm
7 and ground — 2,000 ohms

Check any deviation against the schematic to isolate the trouble to either the tube or transformer compartment of the oil unit.

k. If the above measurements indicate a break-down in the transformer compartment, it is necessary to replace the whole compartment and send it to the factory for repair.

l. If the above measurements indicate trouble in the tube compartment, the compartment should be opened in accordance with instructions set forth in paragraph 53b(4).

PROBABLE LOCATION OF FAULT	PROCEDURE
3. Modulator unit (contd).	*m.* If the symptom is frequent cut-off accompanied by ticking sounds in the oil unit, but unit otherwise operates properly, trouble is usually caused by excessive flash-over in tube 106-1 or 106-2. Replace both tubes. *n.* If *m* is not the symptom, make the following checks: *o.* If test in *j* does not show *open* between 2 and ground, remove tubes 105-1 and 105-2 and check again. If still not an open circuit, probable source of trouble is spark gap 113-1. Clean the spark-gap chamber thoroughly of all oil and carbon and install a new spark-gap plug. The plug should be pressure tight and sealed into the chamber with a small amount of glyptal on the threads. *p.* If symptom does not come under any of the above headings, make up a short cable to connect air and oil units without actually mounting the oil unit, and connect a voltmeter between banana jacks 3 and 7. This voltmeter is then across the windings of the overload relay in the air unit. In proper operation the drop across this winding should be approximately 5 to 10 volts direct current and the relay should cut out at approximately 50 milliamperes. If voltage drop is less than normal, it indicates an open filament in tube 105-1 or 105-2 or an open circuit in the oil unit. Open the tube compartment, check first the filaments of tubes 105-1 and 105-2. If these test good, make continuity checks in the tube compartment, using the schematic diagram as a guide. *q.* If the voltage across the windings of the overload relay is excessive, disconnect the filaments of tubes 105-1 and 105-2 by opening the lead connected to banana jack 4. Drop across the overload relay should then be much lower than in normal operation. If still excessive, a gassy tube is indicated. If a variac or transtat can be substituted for autotransformer 19, reduce the a-c line voltage to zero and turn on the modulator. Increase the line voltage to about 20 volts, but no more. (More than 20 volts may cause a flash-over and damage the unit.) See if any tubes have the characteristic glow indicating gas. *r.* If none of the above troubles is indicated or found, it will be necessary to resort to use of the schematic diagram and an ohmmeter to check all the components and interconnections of the oil unit or to replace the unit.

B. SYMPTOM:

No reading observed on plate current meter, although sweep lines are observed on either PPI or Class A oscilloscope, or both.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Plate meter circuit.	1*a*. Examine oscilloscopes for echoes or main pulse; if present, the trouble is in the meter or meter circuit; if not present, proceed to next probable fault. *b*. Using schematic diagram of the r-f unit (fig. 29) make resistance and continuity tests in the meter circuit. *c*. Check protector gap 16, 17 for short across the gap. *d*. Check capacitor 68 for breakdown or short across the capacitor. Replace if necessary. *e*. Replace meter.
2. Transmitter tube circuit.	2*a*. Connect echo box and check for r-f output from the magnetron (par. 37f). If no r-f, fault is definitely in transmitter tube, transmitter tube circuit, or magnet. Proceed to next step. *b*. Replace transmitter tube; if trouble persists, proceed to next step. *c*. Check for broken or loose connections in the filament-heating circuit. Check leads into the banana jack connections on glass part of tube. *d*. Turn off all power to the set. Refer to the schematic diagram of the r-f unit (fig. 29). Make continuity and resistance checks in the filament-heating circuit with ohmmeter. If these checks do not locate the trouble, proceed to next step. *e*. Check continuity of windings of filament transformer 10 in r-f unit; replace transformer if faulty. *f*. Check continuity of windings of input transformer 1 in r-f unit; replace transformer if faulty. *g*. With schematic diagram of the r-f unit (fig. 29) and ohmmeter, check for break-down of capacitor 30-A, 30-B, 40-1, 40-2, or 37. Replace any capacitor found defective. If these tests do not locate the trouble, proceed to the next step. *h*. Replace magnet.

C. SYMPTOM:

Plate current meter reading is normal, but no sweep line appears on either PPI or Class A oscilloscope.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Triggering pulse circuit.	1*a*. Check for firm connections, check cable continuity with ohmmeter, replace cable if defective. *b*. Using schematic diagrams of indicator unit and r-f unit (figs. 59 and 29), check for broken or loose connections in the triggering pulse circuit.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Triggering pulse circuit (contd).	*c.* Check continuity of the triggering pulse pick-up loop winding (terminal 7 to ground) of input transformer 1 in r-f unit. If winding shows open or defective, replace transformer. *d.* See section VIII, Trouble Shooting in Indicator System.
2. Sweep circuits in indicator system.	2. See Section VIII, Trouble Shooting in Indicator System.

D. SYMPTOM:

Plate current meter does not read 10 to 18 milliamperes, other indications normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper adjustment of a-c line voltage from power unit.	1. Check voltage and adjust to proper setting of 115v. See TM 11-933, Power Unit PU-6/TPS-1.
2. Defective high-voltage rectifier tube 705A in modulator unit.	2. Replace tube (par. 53b).
3. Defective input transformer 1 in r-f unit.	3. Make continuity checks of the input transformer in r-f unit.
4. Defective transmitter tube.	4. Replace tube (par. 53e).
5. Rotating joint 23.	5. See section VI, Trouble Shooting in Radio-Frequency System.
6. Overload in transmitter system but not enough to operate overload relay.	6. See symptom E below for procedure in locating fault.

E. SYMPTOM:

Normal plate meter reading shows temporarily but drops to zero.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Kick-offs.	1. Starting cold, there may be kick-offs for a number of minutes. In that event, press the TRANSMITTER ON button again after each kick-off. Occasional kick-offs may occur even after set has been operating for some time.

PROBABLE LOCATION OF FAULT	PROCEDURE
2. Overload in the transmitter system.	2*a*. Test for overload by pressing the TRANSMITTER ON button for several seconds, but no longer. If an overload exists, the relay will continue to open and close as long as the finger is held on the TRANSMITTER ON button. *b*. Flash-overs in high-voltage rectifier tubes 106-1 or 106-2 in the oil compartment of the modulator unit cause overload relay to operate. Refer to subparagraphs *p* and *q*, fault 3, symptom A above, for procedure in locating the cause of the overload.

F. SYMPTOM:

Plate current meter pointer is unsteady.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Meter circuit.	1*a*. Refer to the schematic diagram for r-f unit (fig. 29) and check for loose or shorted connection or broken or defective wire in the meter circuit. *b*. Check for broken or defective meter; replace meter if defective.
2. Unstable operation of transmitter tube.	2*a*. Check 115v a-c voltage from power unit at the OUTLET, 115V, 400~, on the indicator unit panel. Adjust if necessary. See TM 11-933, Power Unit PU-6/TPS-1. *b*. Replace magnetron (par. 53e). *c*. If trouble persists, refer to fault No. 3, symptom A above, for procedure in checking faulty modulator causing low voltage supplied to the transmitter tube.

52. FIELD CHECK OF MODULATOR UNIT MD-2/TPS-1 PULSE-REPETITION RATE.

a. General. The modulator pulse-repetition rate should be close to 400 cycles per second. It is advisable to check the rate after changing tubes in the air unit, or if trouble is suspected.

b. Steps in Checking.

(1) Set the controls on Test Set TS-96/TPS-1 (stored in tower section No. 2, Indicator Unit ID-16/TPS-1A) to read on the 600-volt a-c scale.

(2) Insert one meter cord test pick in the center conductor of the IFF PULSE + connector.

(3) Insert the other meter cord test pick in the ungrounded terminal slot of the OUTLET 115V 400~ power outlet.

(4) With the complete radio set functioning, turn the CLASS A GAIN control knob to its extreme counterclockwise position.

(5) Observe the sweep line on the Class A oscilloscope. If the modulator pulse repetition rate is the same, or very close to being the same, as the frequency of the power supply (which is nominally 400 cycles per second), the sweep line will be a single line with the shape of a portion of a sine wave and will be stationary, or moving slowly. If the oscilloscope pattern consists of two parallel "sweep lines" separated by an area of many moving sine wave parts, turn the FREQ ADJ potentiometer on the left-hand side of the modulator (fig. 18) until the stationary single-line figure is obtained and then back off the control slightly.

(6) If this figure is not obtainable, check the circuits of air unit tubes 160 (6AG7) and 161 (829), following the instructions given in paragraph 51, symptom A, Fault No. 3.

53. REPLACEMENT OF PARTS.

a. Replacement of Oil Unit of Modulator (fig. 21). (1) Unscrew the four modulator top cover screws on each side, the three face screws on each front side, and the two base bolts on each front side.

(2) Carefully lift out the oil unit, pulling straight up to disengage the eight vertically mounted banana plugs (of the air unit) from the oil unit jacks (fig. 19).

(3) To replace the oil unit, carefully lower it into place, feeling for the engagement of the air unit connecting banana plugs into the oil unit jacks.

(4) Tighten the two base bolts and the three face screws on each front side and the four modulator top cover screws on each side.

b. Replacement of Vacuum Tubes in Oil Unit Assembly of Modulator Unit (fig. 20).

(1) In changing the vacuum tubes in the oil unit and refilling the unit with oil, *never remove oil from nor open the transformer compartment* (fig. 18).

(2) Remove the silver-coded cord from the pulse cord connector (110), and cover the connector with the chained cap to prevent oil from getting into the connector.

(3) Remove the oil filler plug on top of the tube oil expansion chamber (fig. 18) and empty the oil into the 2-quart measure stored in tower section No. 3. Keep this oil clean so it can be used to refill the chamber.

(4) Remove the tube compartment housing by removing the Allen cap screws (fig. 18) with the Allen wrench which is clipped to the front of the mounting framework in tower section No. 1. Be careful of the base gasket in removing the housing. The tube compartment is now exposed (fig. 20).

(5) Make the necessary tube replacements.

(6) Replace the tube compartment cover; tighten all screws.

(7) Tilt the oil unit slightly so that the oil filler cap hole is at the highest part of the expansion chamber (fig. 18).

(8) Pour in clean oil through oil filler cap hole until the unit is half full, jiggling the unit slightly to assist the air in bubbling to the surface.

(9) Attach suction end of the rubber bulb of the pipette (fig. 81) which is stored in the tool kit, to the valve stem of the expansion bladder. Deflate the bladder completely, with the oil unit in a horizontal position.

(10) Measure the oil temperature by immersing the thermometer which is stored in the tool case in the oil for 3 minutes. Have thermometer encased in its armored guard (fig. 81). From the oil level chart (fig. 80) read the correct level for temperature of oil. With the 6-inch steel scale measure the oil level from the bottom of the expansion chamber to the oil surface. Add or remove oil with the pipette (fig. 81). Adjust the level in the expansion chamber according to the oil temperature as shown in the chart. Check oil level with the 6-inch scale until correct.

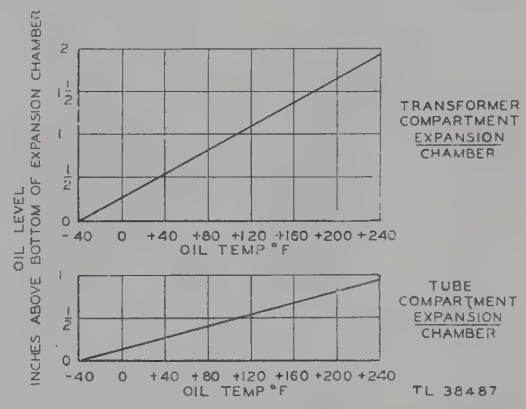


Figure 80. Oil level chart for modulator unit.

(11) Change to the other end of the bladder bulb assembly and inflate the bladder just enough to raise the level of the oil up to the threads of the oil filler plug hole. Jiggle the unit slightly to exclude air bubbles. Keeping the oil at this level and taking care that no air enters the chamber, insert and tighten the filler cap (fig. 18).

(12) Remove the rubber bulb and attach the bladder stem cap.

c. Replacement of Vacuum Tubes in Air Unit Assembly of Modulator Unit. (1) Open the door at the back of the modulator by releasing the wing locks (fig. 23).

(2) Loosen the thumbscrew holding the tube clamps in place.

Figure 81. Measuring oil, using thermometer, pipette and scale.

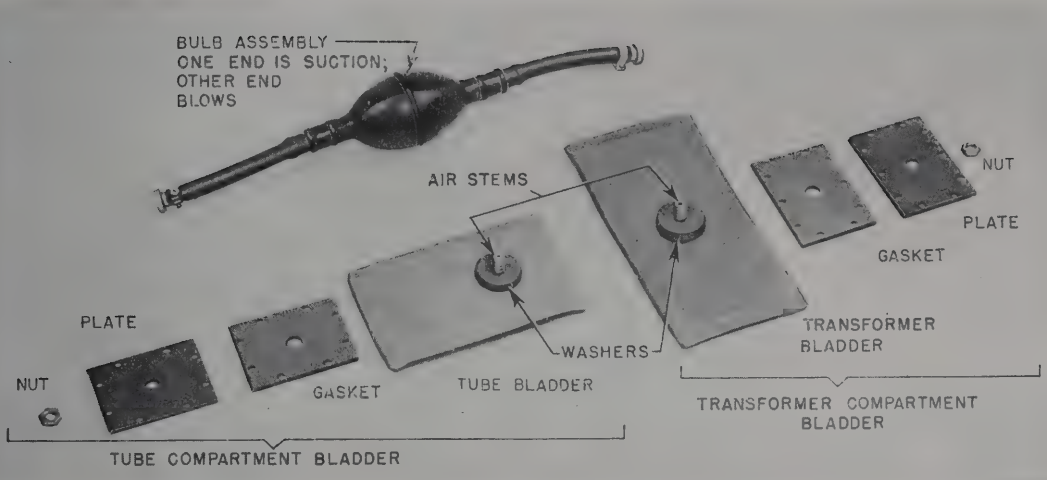


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Figure 82. Oil unit, expansion chamber bladders.

(3) Remove the tube grid clips.
(4) Remove the tubes.
(5) Replace the tubes, the clamps, and the grid clips.
(6) Close and reclamp the door.
(7) If either driver tube 160 (6AG7) or driver tube 161 (829) is replaced, check the repetition rate of the multivibrator oscillator circuit, as described in paragraph 52.

d. Replacement of Expansion Bladder (one or the other at a time) (fig. 82). (1) It is not necessary to empty the oil from the tube compartment and oil *must not* be emptied from the transformer compartment. During this procedure, handle the oil unit carefully in an upright position to insure that no air passed from the upper (expansion) chamber (where the bladder is) to the lower chamber.
(2) Be sure the pulse cable connector cap is screwed on to prevent oil from getting into the connector. Remove both the oil filler plug and the bladder plate (fig. 18).
(3) Remove the old bladder and attach a new one to the bladder plate carefully tightening the holding nut. Insert this new assembly into the expansion chamber (fig. 83). Be sure the bladder lies flat and straight without folds in the chamber. Install new gaskets if necessary. Carefully tighten the screws holding the bladder plate to the tube or transformer compartment cover.
(4) Pour clean oil slowly through the filler plug hole until the expansion chamber is half full, jiggling the unit *slightly* to assist in expelling all the air bubbles from the oil.
(5) Restore the whole unit to the horizontal position. Proceed as in subparagraph b above to establish the correct oil level.

e. Replacement of Magnetron 5J21, 5J22, 5J23, 5J24, or 5J25 (fig. 26). (1) Remove the back panel of Radio-Frequency Unit RF-1/TPS-1 with a screwdriver.
(2) From the rear of the unit pull the two banana plug connectors out of the jacks on the glass frame of the magnetron tube.
(3) Loosen the magnetron clamping ring (fig. 84) by turning it counterclockwise with the capstan bar packed in the tool case. As the ring is loosened it will bind unless the magnetron is pulled or loosened at the same time. Therefore apply alternately a pull and turn procedure in order to turn the ring until it is free of the threads.
(4) From the rear of the unit, remove the magnetron tube (fig. 85).
(5) To replace a magnetron, slide the "snout" with the positioning pin to the right (fig. 26) into the cylindrical opening in the magnetron housing casting.
(6) Position the faces of the magnetron tube parallel to the housing sides and push it into place, engaging pin in slot in the housing.
(7) From the front of the unit, screw the magnetron clamping ring into place and draw it up tightly with the capstan bar.
(8) At the rear of the unit, connect the banana

Figure 83. Inserting new bladder in modulator oil unit.

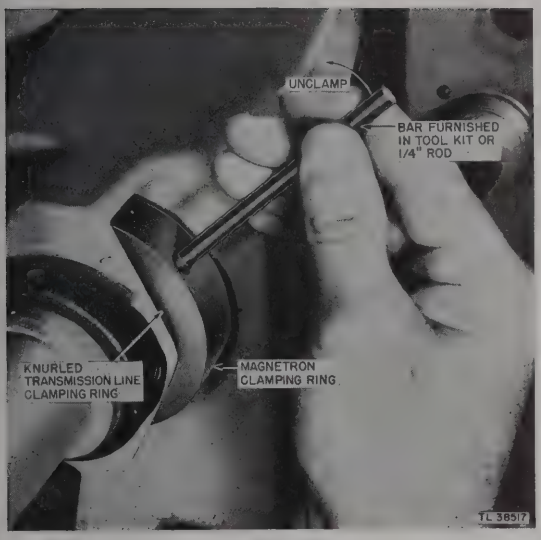


Figure 84. Unscrewing magnetron clamping ring.

plugs to the jacks in the glass frame of the tube.

(9) Replace the back panel of the unit.

(10) After having installed a different magnetron, it is necessary to realign the set according to the procedure in paragraph 37h.

54. TESTING OF COMPONENTS.

a. General Information. The following tests can be used to check the individual components of the transmitter system. Modulator Unit MD-2/TPS-1 needs to be associated with an Indicator Unit ID-16/TPS-1A for testing; Radio-Frequency Unit RF-1/TPS-1 needs to be associated with a Modulator Unit MD-2/TPS-1, an Indicator Unit ID-16/TPS-1A, and a Control Unit C-13/TPS-1 for testing. These auxiliary units may be other than those with which the unit under test is normally associated in a particular system. This may lead to slight differences in performance which are not expected to be significant. In general it will be desirable not to erect the units as a tower, particularly when using the probe connection on the dummy antenna. Apparatus designations in general are stamped on or near the part under discussion. Also check against the appropriate schematic diagram, wiring diagram, or assembly drawing.

b. Test Equipment. (1) The following equipment and facilities are required to perform the tests described below. Information on special test equipment can be obtained from the handbooks describing such equipment.

(*a*) Power supply: 400 cycles, 115 volts, 1,250 watts; and 27 volts direct current, 300 watts.

(*b*) Signal Generator TS-103/TPM-1.

(*c*) Test Unit TS-104/TPM-1.

(*d*) Line Monitor TS-106/TPM-1.

(*e*) Voltage Divider TS-98/AP.

(*f*) Frequency and Power Measuring Set TS-107/TPM-1.

(*g*) Dummy Load TS-90/AP.

(*h*) Test Oscilloscope TS-34/AP.

(*i*) Electrodynamometer type voltmeter: 400 cycles, range to 150 volts.

(*j*) Test Set TS-96/TPS-1 (precision multirange tester, 856P).

(2) In addition to the above items of test equipment, the following parts of Radio Set AN/TPS-1A should be available. These may be parts of the same set as the unit under test, or depot spares, and should be in good operating condition.

(*a*) Set of connecting cords for Radio Set AN/TPS-1A, as listed in table I (par. 2).

(*b*) Indicator Unit ID-16/TPS-1A, for use

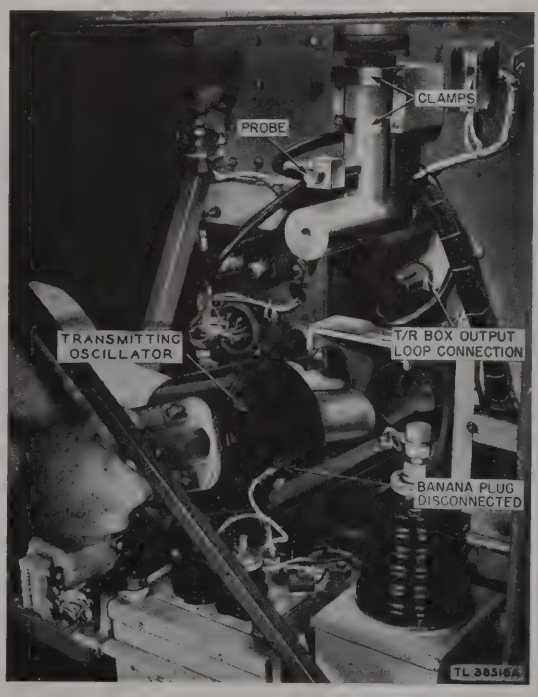


Figure 85. Removing magnetron.

in tests on the modulator unit and on the transmitter and receiver circuits.

(*c*) Modulator Unit MD-2/TPS-1, for transmitter tests.

(*d*) Control Unit C-13/TPS-1, for transmitter tests.

c. Tests on Modulator Unit MD-2/TPS-1. The tests that are made on the modulator in connection with the transmitter system consist of measuring the prepulse of the air unit, measuring the oil unit output, and adjusting the pulse-repetition rate. An over-all test of the modulator is made by measuring the oil unit output. If the oil unit output does not meet the requirement, it is then necessary to measure the air unit output. The procedure for making the measurements follows.

(1) TESTING AIR UNIT.

(*a*) Place Voltage Divider TS-98/AP over the banana plugs of the air unit.

(*b*) Make the same connections as listed in paragraph 46c.

(*c*) A portion of the drive pulse of the multivibrator of the air unit is connected back to Test Unit TS-104/TPM-1 and appears at a jack, as described in the instructions for the test unit. Connect from this jack to the signal input circuit of the oscilloscope.

(*d*) Operate the POWER switch of the indicator unit to ON and allow at least 2 minutes for warm-up. Adjust the variac in the line monitor so that the line voltage measures 115 volts as measured by the 400-cycle voltmeter at the test unit.

(*e*) Operate the TRANSMITTER ON button of the indicator unit. After a short time a pulse should appear on the screen of the test oscilloscope. Adjust the oscilloscope in accordance with its operating instructions and observe the shape of the pulse. The pulse should appear as a long flat-top pulse of 6 to 8 microseconds duration (fig. 86).

(*f*) Measure the synchronizing pulse voltage as described in the instructions for the oscilloscope-calibrating circuit of Signal Generator TS-103/TPM-1. The peak-to-peak voltage of the synchronizing pulse should be 2.0 $\pm$0.5 volts. Operate the TRANSMITTER OFF button.

(*g*) Connect the oscilloscope signal circuit to the binding posts of Voltage Divider TS-98/AP, using the probe amplifier of the oscilloscope.

(*h*) Operate the POWER switch of the indicator unit to ON and check the line voltage as described in (*d*) above.

(*i*) Operate the TRANSMITTER ON button of the indicator unit. After a short time a pulse should appear on the screen of the oscilloscope. Adjust the test oscilloscope in accordance with its operating instructions and observe the shape of the pulse. The pulse should appear as a jagged-top pulse of 2 microseconds duration (fig. 86).

(*j*) Measure the voltage of the air unit output pulse, using the oscilloscope-calibrating circuit of Signal Generator TS-103/TPM-1. The peak-to-peak voltage of the pulse should be 35 $\pm$5 volts.

(*k*) Measure the 700-volt medium rectifier voltage by connecting the Test Set TS-96/TPS-1 voltmeter negative lead to TERM. 1 of Voltage Divider TS-98/AP and the positive lead to TERM. 3. The voltmeter should read 70 $\pm$5 volts.

(*l*) Measure the 1,200-volt screen voltage by connecting the negative lead of the voltmeter to TERM. 3 and the positive lead to TERM. 2 of the voltage divider. The voltmeter should read 120 $\pm$5 volts. If the reading is not within this tolerance, the tubes should be replaced.

(*m*) Measure the 27-volt a-c pulse amplifier filament supply by connecting the voltmeter between TERM. 3 and TERM. 4 of the voltage divider. The voltmeter should read 27 $\pm$1.5 volts alternating current.

(*n*) Measure the 115-volt a-c supply to oil unit by connecting the voltmeter between TERM. 5 and TERM. 6 of the voltage divider. The voltmeter should read 115 volts alternating current.

(*o*) Operate the TRANSMITTER OFF button, turn off the power at the POWER switch of the indicator unit, remove the voltage divider, and replace the oil unit on the modulator air unit.

(2) MEASURING OIL UNIT OUTPUT.

(*a*) Connect the silver pulse cable to the output connector of the modulator. This cable must be screwed tightly to the output connector so that the rubber is compressed, leaving no air spaces. This is necessary to prevent corona losses and deterioration of the insulation. Connect the opposite end of the pulse cable to the input connector of Dummy Load TS-90/AP.

(*b*) Connect from the MEASURE PULSE

output terminals of the dummy load to the signal input of the test oscilloscope using the probe amplifier.

(*c*) *Turn the variac on the test unit to zero volts.*

(*d*) Operate the POWER switch at the indicator unit to ON. Check that the line voltage at the line monitor is 115 volts as measured at the test unit.

NOTE: Allow at least 2 minutes to elapse after operating the POWER switch to ON before operating the TRANSMITTER ON button.

(*e*) Operate the TRANSMITTER ON button. Turn the variac in the test unit up slowly until the a-c voltage on the oil unit is about 70 volts as measured at the test unit jack, using the 400-cycle voltmeter as described in the instructions for the test unit. The wattmeter in the test unit should read approximately 420 watts.

NOTE: New 5D21 (105-1, 105-2) vacuum tubes (in the oil unit) are subject to frequent internal flash-over; used tubes also flash over occasionally, particularly while warming up. When this occurs the overload relay in the air unit operates, releasing relay 365 in the indicator unit and opening the power circuit to the modulator. Therefore, immediate operation of the overload relay does not necessarily indicate trouble. The flash-over is accompanied by a sharp ticking sound in the oil unit. With the variac set low (approximately 70 volts), the tubes should "clean up" after several flash-overs so that the modulator will start and run, at least for several seconds, before another flash-over occurs. It is necessary to reoperate the TRANSMITTER ON button each time that relay 365 releases, in order to restore power to the modulator unit.

(*f*) Shortly after the TRANSMITTER ON button has been operated and the modulator has started functioning, a pulse should appear on the test oscilloscope screen. When the modulator is running smoothly, with only infrequent tube flash-overs, turn the variac up slowly until it has been adjusted to supply 115 volts to the high-voltage rectifier. At first this may cause more flash-overs but the tubes should "clean up" within a few minutes. The wattmeter in the test unit should now read approximately 800 watts.

(*g*) Display the pulse and observe its shape. The pulse should appear as a flat-top pulse of 2 microseconds duration (fig. 86). Measure the pulse voltage as described in the instructions for the oscilloscope-calibrating circuit, Signal Generator TS-103/TPM-1. The peak-to-peak voltage of the pulse should be 80 $\pm$10 volts.

(*h*) The modulator should operate smoothly with a line-voltage and high-voltage rectifier input voltage of 125 volts, and the pulse shape should be the same as for 115 volts.

(*i*) The modulator should operate smoothly with a line-voltage and high-voltage rectifier input voltage of 105 volts, and the pulse shape should be the same as for 115 volts.

(3) ADJUSTING REPETITION RATE OF MODULATOR UNIT MD-2/TPS-1. After changing vacuum tubes 160 or 161 in the multivibrator circuit of the modulator, the repetition rate may need to be readjusted to the normal rate of about 400 pulses per second. The rate can be adjusted either with the modulator installed in an operating set, or with the modulator not in a set (if properly supplied with power).

(*a*) *Modulator Installed in Radio Set AN/TPS-1A.* When the modulator is installed in the radio set, which is powered from a 400-cycle source, adjustment of the repetition rate to near 400 cycles causes the plate current of the magnetron to fluctuate, as indicated by an unsteady reading on plate current meter 12. Also, if the repetition rate bears a whole-number relation to the range-marker timing, double marker pulses may be produced. Therefore, a compromise adjustment is made between the frequency at which beats are produced in the magnetron plate current, and the lower frequency at which double range-marker pulses may be obtained. Adjust the repetition rate by turning the FREQ ADJ potentiometer on the left-hand side of the modulator with a screwdriver to the point where beating is observed. Then press the RANGE MARKER button on the indicator unit panel, and (observing the class A oscilloscope trace, with the RANGE control set for about 20 miles) rotate the FREQ ADJ potentiometer counterclockwise until double marker pips are observed. Set the FREQ ADJ potentiometer to a point between the two positions noted above. If no double marker pips are produced, set the FREQ ADJ potentiometer slightly off from the point where beats are observed on the meter.

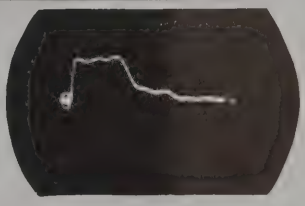
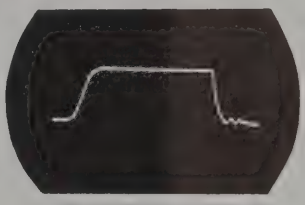
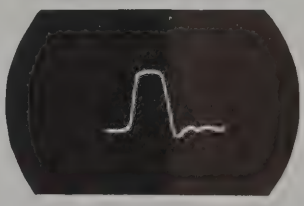
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORMS OF VOLTAGE TO GROUND
AIR UNIT OF MODULATOR MD-2/TPS-1	1-REMOVE CABLE AT JACK 110 (HIGH VOLTAGE PULSE OUTPUT) ON MODULATOR. 2-REMOVE OIL UNIT AND ATTACH VOLTAGE DIVIDER TO AIR UNIT.	OUTPUT PULSE OF VOLTAGE DIVIDER	
		PREPULSE OF AIR UNIT	
OIL UNIT OF MODULATOR MD-2/TPS-1	1-CONNECT DUMMY LOAD TO MODULATOR THROUGH SILVER CABLE. 2-CONNECT TEST OSCILLOSCOPE TO DUMMY LOAD.	OUTPUT PULSE OF OIL UNIT	
RADIO FREQUENCY UNIT RF-1/TPS-1	1-COUPLE DUMMY ANTENNA TO R-F TRANSMISSION LINE 2-CONNECT DUMMY ANTENNA PROBE TO FREQUENCY AND POWER MEASURING SET	RADIO FREQUENCY PULSE	

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Figure 86. Transmitter system and r-f system test waveforms.

(b) *Modulator Not Installed in Complete Radio Set.* Use the following procedure for checking or adjusting the repetition rate of the modulator if a complete set is not to be used.

1. Connect Line Monitor TS-106/TPM-1 to the GENERATOR connector of the indicator unit.
2. Connect the cord between the C RF UNIT connector and Test Unit TS-104/TPM-1.
3. Connect the red-coded cord between the MODULATOR connector of the test unit and the red connector on the modulator unit.
4. Connect the silver pulse cord between the connector on the modulator unit and the input connector on Dummy Load TS-90/AP.
5. Connect the output terminals of the dummy load to the synchronizing jack of the test oscilloscope.
6. Connect an audio-frequency oscillator to the signal input jack of the test oscilloscope, using the probe amplifier.
7. *Turn the variac control on the connector box to zero volts.*
8. Throw the POWER switch on the indicator unit panel to the ON position. Check that the line voltage at the line monitor is 115 volts.

NOTE: *Allow at least 2 minutes to elapse after throwing the POWER switch to ON before pressing the TRANSMITTER ON button.*

9. Press the TRANSMITTER ON button on the indicator unit panel. Turn the variac control in the test unit up slowly until the voltage is raised to 115 volts.
10. A pulse should appear on the oscilloscope screen which can be made to appear stationary by adjusting the frequency of the audio-frequency oscillator.
11. Set the oscillator frequency to about 394 cycles per second. Adjust the FREQ ADJ control on the left-hand side of the modulator unit to produce a stationary figure on the oscilloscope. The repetition rate has now been adjusted.

d. Transmitter Tests.

(1) GENERAL OPERATION.

(*a*) Connect the units for system operation. Connect the line monitor into the power line and couple the dummy antenna to the transmission line of Radio-Frequency Unit RF-1/TPS-1 which is under test.

(*b*) Measure the 400-cycle voltage at the line monitor. Adjust the line monitor variac for 115 volts.

(*c*) Throw the POWER switch of the indicator unit to the ON position. Allow at least 3 minutes for the apparatus to warm up.

(*d*) Operate the TRANSMITTER ON button of the indicator unit.

(*e*) Readjust the line voltage to 115 volts.

(*f*) The plate (magnetron) current meter 12 should read between 10 and 18 milliamperes.

(*g*) The overload relay in the modulator unit should not operate too often, as explained in subparagraph c(2) (*e*) above.

(*h*) When the magnetron current is less than 10 milliamperes, first check the line voltage. If, with 115 volts at the line monitor, the current is below 10 millamperes, change the tap on autotransformer 19 in the r-f unit to a higher voltage position. This tap should be adjusted for maximum magnetron current consistent with good operation of the modulator unit.

(*i*) Should the transmitter fail to operate, completely check the wiring and power supply to the magnetron.

(*j*) See that all connections are made properly to the pulse transformer.

(*k*) Be sure that microswitch 38 has closed when seating the magnet in the r-f unit.

(*l*) Check that the transmission line and connection to the dummy antenna are in working condition.

(2) MEASUREMENT OF FREQUENCY.

(*a*) Connect the units as in subparagraph (1) above. To the output probe of the dummy antenna connect the frequency and power measuring set, as described for measurement of frequency in the instructions for Frequency and Power Measuring Set TS-107/TPM-1.

(*b*) Operate the POWER switch of the indicator unit to the ON position. Allow at least 3 minutes for the apparatus to warm up.

(*c*) Operate the TRANSMITTER ON button of the indicator unit.

(*d*) Adjust the line voltage to 115 volts.

(*e*) With the radio set transmitter in operation, measure the frequency of the transmitter as described in the instructions for Frequency and Power Measuring Set TS-107/TPM-1.

(*f*) This frequency should be in the band corresponding to the code number of the magnetron.

(*g*) Note this frequency for future use.

(3) RADIO-FREQUENCY PULSE SHAPE.

(*a*) Connect the units as in subparagraph (1) above. Connect the dummy antenna probe to the frequency and power measuring set for viewing pulses as described in the instructions for Frequency and Power Measuring Set TS-107/TPM-1.

(*b*) Operate the POWER switch of the indicator unit to the ON position and allow at least 3 minutes for the apparatus to warm up.

(*c*) Operate TRANSMITTER ON button.

(*d*) Adjust the line voltage to 115 volts.

(*e*) Observe the pulse shape on the test oscilloscope as described in instructions for Test Oscilloscope TS-34/AP and Frequency and Power Measuring Set TS-107/TPM-1. The pulse should be a wide flat-top pulse of 1.5 microseconds duration (fig. 86).

(*f*) If the pulse shape differs very greatly from the expected shape, check that capacitor 32 and resistor 49 of Radio-Frequency Unit RF-1/TPS-1 are properly connected and in operating condition. Check all connections and capacitors at pulse transformer 1.

(*g*) Measure the length of the pulse in microseconds as described in the instructions for Test Oscilloscope TS-34/AP.

(*h*) The pulse length should be approximately 1.5 microseconds.

(*i*) Any discrepancies between the pulse shape measured and that required are usually caused by the modulator unit, which should be tested separately.

(4) MEASUREMENT OF POWER.

(*a*) Connect the units as in subparagraph (1). Connect the dummy antenna probe to the frequency and power measuring set for power measurement, as described in the instructions for Frequency and Power Measuring Set TS-107/TPM-1.

(*b*) Throw the POWER switch of the indicator unit to the ON position and allow at least 3 minutes for the apparatus to warm up.

(*c*) Operate the TRANSMITTER ON button of the indicator unit. See note in subparagraph c (2) (*e*) above.

(*d*) Adjust the line voltage to 115 volts.

(*e*) After the transmitter has been operating for approximately 5 minutes, measure the power as described in the instructions for Frequency and Power Measuring Set TS-107/TPM-1.

(*f*) This is a measure of the average power into the frequency and power measuring set. In order to determine the average output power of the transmitter, it is necessary to know the loss from the transmission line to the power meter. If the frequency is 1,080 megacycles, the combined loss of the probe and the 10-db pad is 43 decibels. This represents a power ratio of 20,000/1. At other frequencies a correction must be made in accordance with the probe loss calibration.

(*g*) From the measurement of the pulse-repetition rate of the modulator unit [subpar. c (3) above], and the pulse length in microseconds from subparagraph d (3) above, the peak transmitter power in kilowatts may be determined by using the following formula:

$$\frac{\text{average power (watts)} \times 1{,}000}{\text{repetition rate (cycles per second)} \times \text{length of pulse (microseconds)}}$$

(*h*) This peak power should be at least 120 kilowatts. For anything less than this, check the transmission line and all couplings and connections.

(*i*) Only as a last resort should the magnetron be changed.

Resistance Measurements at Various Points

Average values calculated from nominal resistance components between the Terminal in Column 1 and the Reference Point in Column 2.

Column 1 Terminal	*Column 2 Reference Point*	*Column 3 Resistance in Ohms*
Capacitor 143, rt term	Ground	18
Capacitor 143, left term	Ground	750
Connector 156, pin 7	Ground	400
Connector 156, pin 1	Capacitor 140, front term	1,800
Connector 154, pin P	Capacitor 144, top term	18,000
Capacitor 117-A	Capacitor 117-B	20,000
Capacitor 117-A	Connector 156, pin 2	20,000
Transformer 119, term 6	Transformer 119, term 1	10,000
Capacitor 145, green lead	Network 115, term 2	10,000
Capacitor 145, green lead	Capacitor 117-A	10,000
Connector 154, pin P	Capacitor 142, blue lead	56,000
Pot 137-1, bottom term	Pot 137-1, top term	60,000
Pot 137-1, top term	Ground	56,000
Connector 154, pin P	Capacitor 147, red lead	1 megohm
Capacitor 140, front term	Pot 137-1, bottom term	0.57 megohm
Capacitor 117-B	Ground	3 megohms
Capacitor 144, bottom term	Pot 137-1, center term	2.7 megohms

Resistance Measurement at Vacuum Tube Socket Terminals

From		*To*	*Resistance in Ohms*
Tube Socket	*Pin*		
160	1	Ground	0
160	2	Ground	0
160	3	Ground	750
160	4	Capacitor 147, red lead	47
160	5	Ground	750
160	6	Capacitor 142, blue lead	47
160	8	Capacitor 144, top term	47
161	1	Ground	0
161	2	Capacitor 144, bottom term	475
161	3	Capacitor 145, green lead	100
161	4	Ground	18
161	6	Capacitor 144, bottom term	475
161	7	Ground	0
161	Plate	Network 115, term 1	47 each plate
162	Plate	Connector 156, pin 1	1,800
162	7	Ground	10,000
106-3	Filament	Ground	3 megohms

Figure 87. Modulator Unit MD-2/TPS-1, air unit resistances.

Resistance Measurements at Various Points

Average values calculated from nominal resistance components between the Terminal in Column 1 and the Reference Point in Column 2.

Column 1 Terminal	*Column 2 Reference Point*	*Column 3 Resistance in Ohms*
Connector 111, jack 3	Connector 110, cent term	0.22 ohm max
Connector 111, jack 5	Connector 111, jack 6	0.36 ohm max
Connector 111, jack 5	Connector 111, jack 8	0.375 ohm max
Connector 111, jack 3	Connector 111, jack 7	2,000 ohms max

Resistance Measurement at Vacuum Tube Socket Terminals

From		*To*	*Resistance in Ohms*
Tube Socket	*Pin*		
105-1 and	Grid	Connector 111, jack 1	47
105-2	Screen	Connector 111, jack 2	22
	Filament	Ground	0
	Plate Clip	Center rod	10
106-1	Filament CT	Center rod	2.15 max
	Plate Clip	Case of capacitor 107-5	4,000 max
106-2	Filament CT	Case of capacitor 107-5	4,000 max
	Plate Clip	Case of capacitor 107-5	2,000

Figure 88. Modulator Unit MD-2/TPS-1, oil unit resistances.

Figure 89. Modulator Unit MD-2/TPS-1, air unit wiring diagram

Resistance Measurements at Various Points

Average values calculated from nominal resistance components between the Terminal in Column 1 and the Reference Point in Column 2.

Column 1 Terminal	*Column 2 Reference Point*	*Column 3 Resistance in Ohms*
Connector 111, jack 3	Connector 110, cent term	0.22 ohm max
Connector 111, jack 5	Connector 111, jack 6	0.36 ohm max
Connector 111, jack 5	Connector 111, jack 8	0.375 ohm max
Connector 111, jack 3	Connector 111, jack 7	2,000 ohms max

Resistance Measurement at Vacuum Tube Socket Terminals

From		*To*	*Resistance in Ohms*
Tube Socket	*Pin*		
105-1 and	Grid	Connector 111, jack 1	47
105-2	Screen	Connector 111, jack 2	22
	Filament	Ground	0
	Plate Clip	Center rod	10
106-1	Filament CT	Center rod	2.15 max
	Plate Clip	Case of capacitor 107-5	4,000 max
106-2	Filament CT	Case of capacitor 107-5	4,000 max
	Plate Clip	Case of capacitor 107-5	2,000

Figure 88. Modulator Unit MD-2/TPS-1, oil unit resistances.

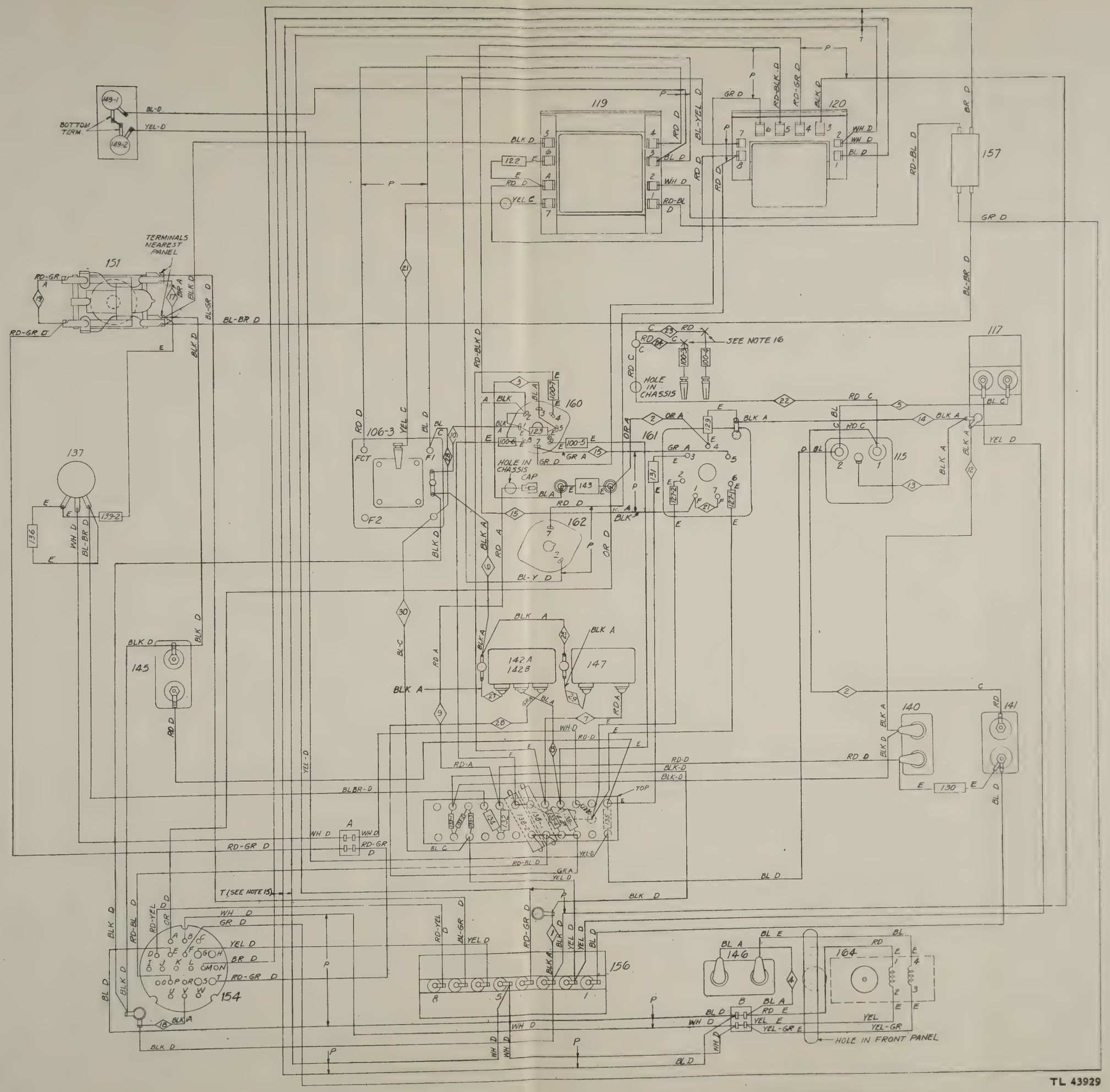

Figure 89. Modulator Unit MD-2/TPS-1, air unit wiring diagram.

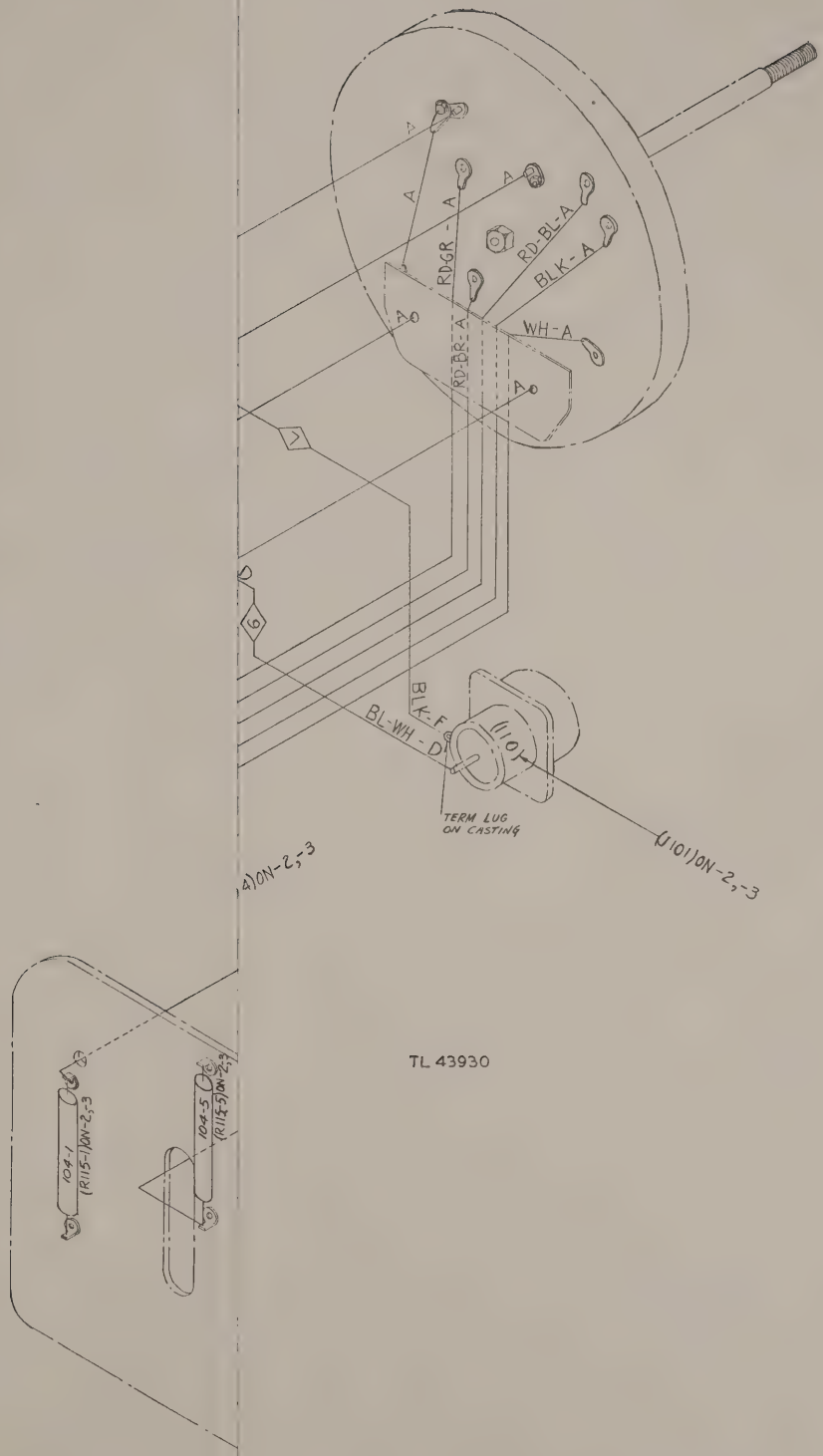

Figure 90. Modulator Unit MD-2/TPS-1, oil unit wiring diagram.

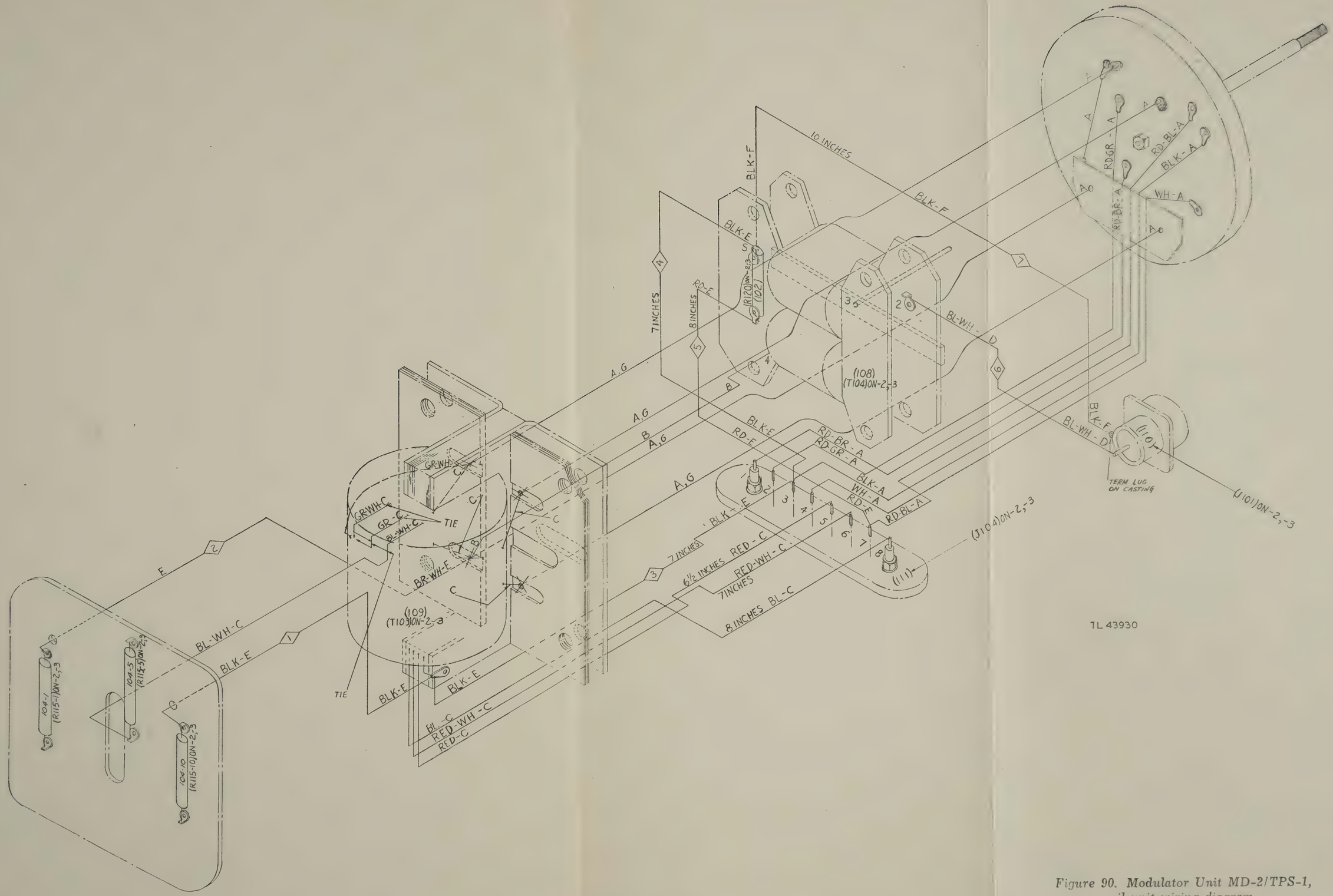

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Figure 90. Modulator Unit MD-2/TPS-1, oil unit wiring diagram.

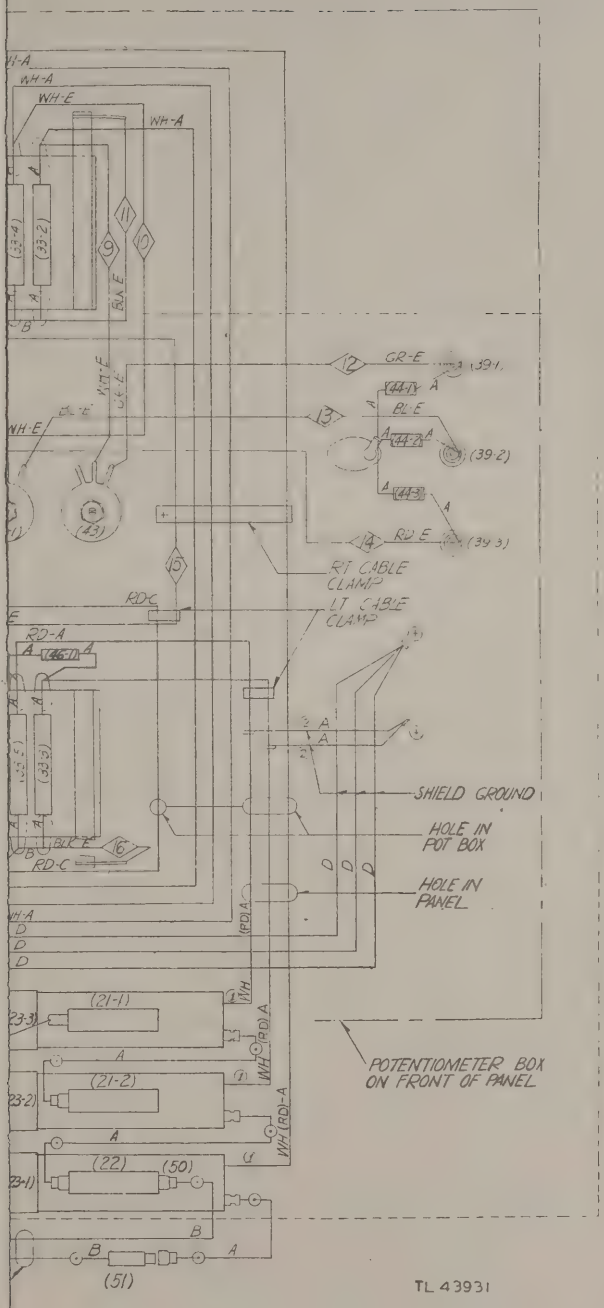

Figure 91. Radio-Frequency Unit RF-1/TPS-1, wiring diagram.

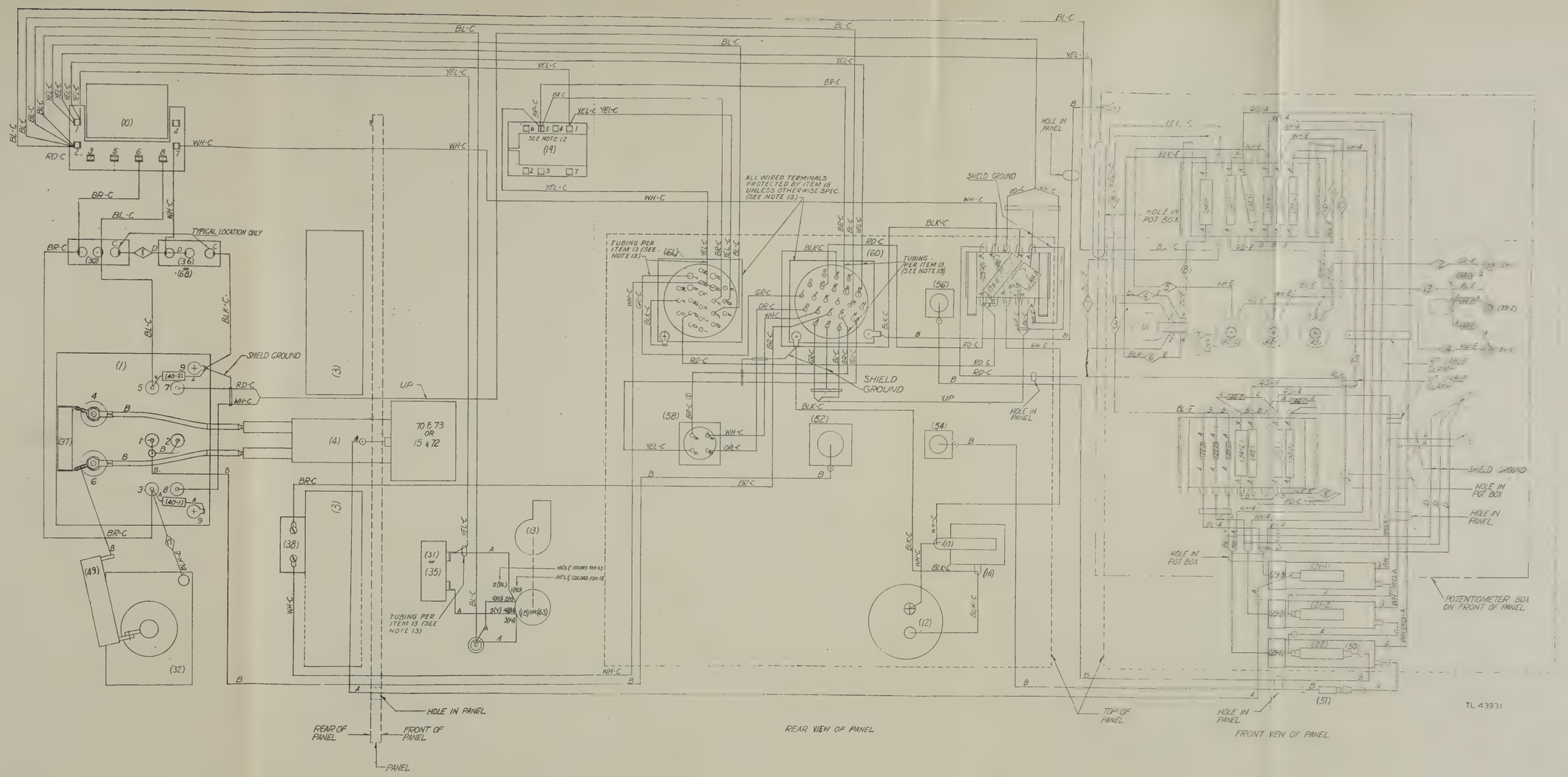

Figure 91. Radio-Frequency Unit RF-1/TPS-1, wiring diagram.

SECTION VI

TROUBLE SHOOTING IN RADIO-FREQUENCY SYSTEM

WARNING: *Voltages sufficient to cause DEATH ON CONTACT are exposed in Radio-Frequency Unit RF-1/TPS-1. Tests and adjustments may be necessary which require power to be applied. Do not put hands, arms, or other parts of the body near high-voltage points located in this unit. Test leads must not come in contact with high-voltage points while power is applied. With power removed, short out high-voltage capacitors before working in the unit.*

5. REFERENCE DATA.

The following figures are included to assist maintenance personnel in trouble shooting the r-f system.

a. Figure 29, Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

b. Figure 30, Location of r-f system parts.

c. Figure 31, R-f system, schematic diagram.

d. Figure 32, Radio-Frequency Unit RF-1/TPS-1, front view.

e. Figure 33, T-R box disassembled.

f. Figure 44, Indicator Unit ID-16/TPS-1A, front panel.

g. Figure 69, Test Set TS-91/TPS-1 (echo box), instruction sheet.

h. Figure 70, Echo box connections for frequency and power measurements and T-R box adjustment.

i. Figure 71, Echo box ringtime on Class A oscilloscope.

j. Figure 84, Unscrewing magnetron clamping ring.

k. Figure 85, Removing magnetron.

l. Figure 86, Transmitter system and r-f system test waveforms.

m. Figure 91, Radio-Frequency Unit RF-1/TPS-1, wiring diagram.

n. Figure 92, Radio-Frequency Unit RF-1/TPS-1, right front view.

o. Figure 93, Removing T-R tube.

p. Figure 94, Radio-Frequency Unit RF-1/TPS-1, bottom front view.

56. INTRODUCTION.

Trouble shooting in the r-f sections of Radio Set AN/TPS-1A is a difficult problem. Most of the troubles are encountered inside r-f lines and connectors. Experience is the greatest factor in this type of trouble shooting. The following chart of symptoms and faults covers some of the difficulties which may be encountered. Because the internal and external conductors must be accurately aligned, repairs should not be attempted on r-f parts in the field unless replacements are impossible to obtain.

57. BEHAVIOR ANALYSIS.

Symptoms of trouble within the r-f system are: weak signals on the oscilloscopes, abnormal pulse waveform, or erratic transmitter current. Trouble should rarely occur within the transmission line. If it does, corrective measures usually consist of replacing a section of line.

a. R-f Arcs in Transmission Line. R-f arcs within the transmission line can be most easily located by finding the origin of the sound of the arc and by feeling the r-f line for warm spots, especially near the transmitter tube. R-f arcs are most likely to be found at the coupling connection between two sections of line.

b. Improper Operation of T-R Box. Improper operation of the T-R box may be determined by loss of sensitivity of the set or by noticeably weakened echoes on the PPI and Class A oscilloscopes. If the T-R box is not operating properly, it may pass a large portion of the transmitted pulse. This condition may or may not be noticeable as an enlarged main pulse on

the Class A oscilloscope, depending on the settings of the receiver gain controls. This improper operation of the T-R box may be the result of a defective T-R tube or improper tuning of the T-R cavity, in which case the T-R box does not pass the received signals effectively and the strength of the signals on the PPI and Class A oscilloscopes is reduced.

c. Transmission Line Tuning Stubs Not To Be Adjusted (fig. 32). The two tuning stubs are provided to permit adjustment of the impedance into which the magnetron oscillator operates. This adjustment, which is made during manufacture of the r-f unit, is not to be disturbed, even though the frequency band may be changed by changing magnetrons.

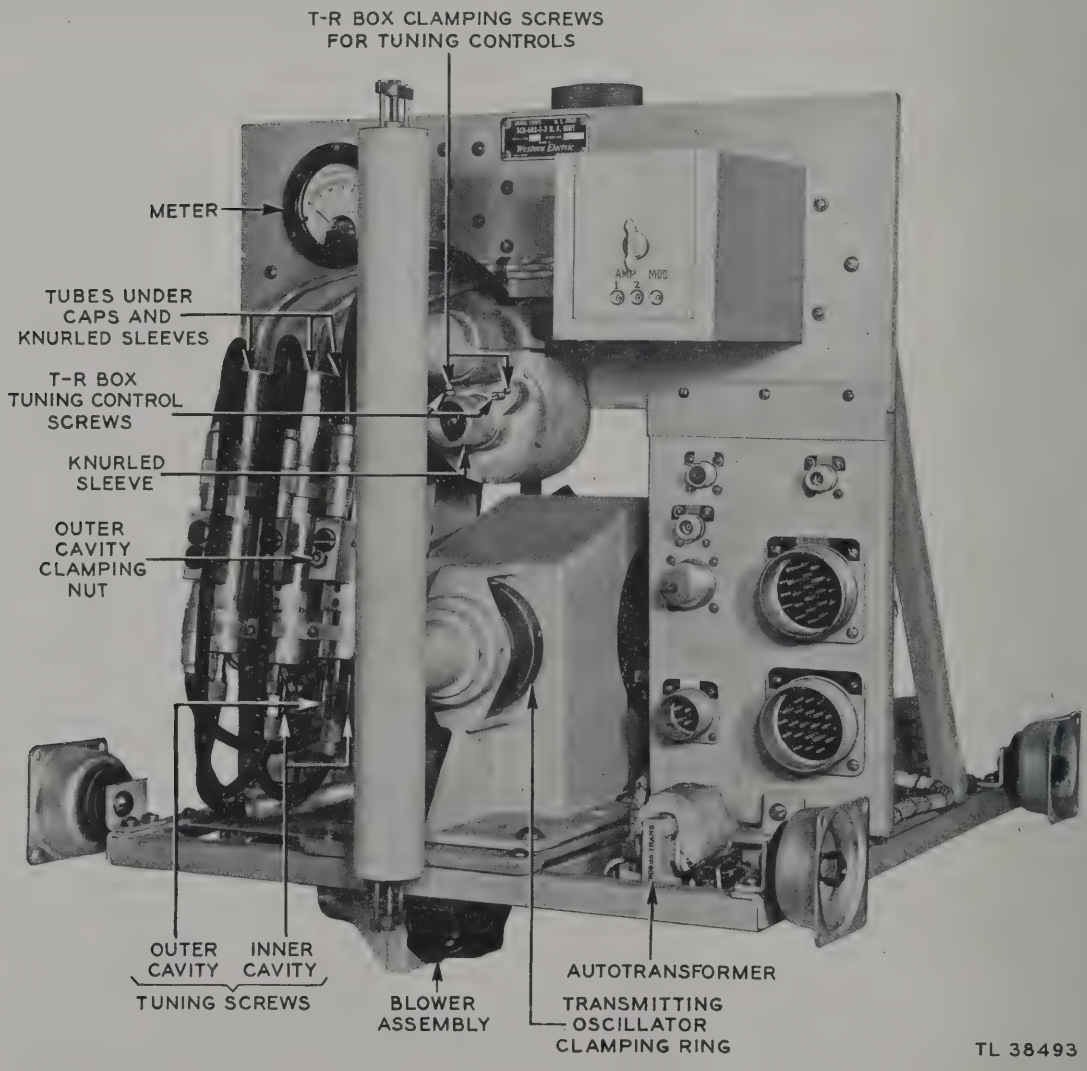

Figure 92. Radio-Frequency Unit RF-1/TPS-1, right front view.

58. R-F SYSTEM, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

High-pitched singing noise coming from the general direction of the r-f line.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. R-f arc at some point inside the transmission line.	1*a*. Locate the origin of the sound by ear or by feeling the transmission line. R-f arcs are most likely to occur at the following places. (1) Coupling connection between transmitter tube and r-f line. (2) Coupling connection between r-f unit and drive section. (3) Rotary joint. (4) Coupling of flexible transmission line at the projector or at the drive section. (5) Unsoldered input coupling loop inside the T-R box. *b*. When the location of the arc is found, turn off the set and remove the section of r-f line containing the arc. See paragraph 59a for removing the r-f line section of the r-f unit. *c*. Examine the interior of the r-f line for signs of burning or pitting. *d*. Replace the entire faulty section unless the damage is very slight and can be corrected by cleaning. If signs of burning are found on the output lead of the transmitter tube, it may be desirable to replace the tube as well as the line section. *e*. Proper procedure for replacing the transmitter tube is given in paragraph 53e.

B. SYMPTOM:

Noticeably weakened echoes on either the PPI or the Class A oscilloscope, although reading on plate current meter is normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Loose or defective r-f line coupling.	1. Check all couplings for good connections.
2. Defective T-R tube.	2. Replace T-R tube (par. 59c). Visual inspection of a tube often determines if it is defective. Check for discoloration of the glass envelope, which is a sign of a defective tube. This discoloration is caused by a thin coating of metal on the glass walls of the tube which creates low resistance paths and detunes the T-R cavity. The formation of this metal coating on the glass walls occurs during normal operation and necessitates frequent replacement of the T-R tube.

PROBABLE LOCATION OF FAULT	PROCEDURE
3. T-R cavity out of tune.	3. Check tuning of T-R cavity (par. 37b).
4. Abnormal condition in receiver system.	4. See section VII, Trouble Shooting in Receiver System.
5. System out of tune.	5. See section II, Use of Specialized Test Equipment.
6. Output loop in T-R box.	6. Do not make this adjustment unless all prior inspections and tests fail to locate the cause of weak signals. Inspect the setscrew and locknut connecting the output loop to the T-R box. If both are too tight to be turned by hand, proceed to the next step. If either or both can be turned by hand, the loop may be out of position within the T-R box. Loosen both the locknut and the setscrew. Remove the cover from the front of the T-R box. With long-nose pliers reach into the T-R box and position the loop by screwing it in or out as necessary until the plug edge is flush with the wall of the T-R box and the loop is in a vertical plane, and the setscrew is felt to go into the positioning hole when tightened. Tighten the locknut on the loop coupling.
7. Moisture in r-f line.	7. When all other tests on the equipment fail to locate the cause of weak signals, check for moisture in the r-f line. Inspect the antenna probe to see if the plastic covering is broken or cracked, allowing moisture to enter the r-f line. If broken, replace this probe covering. Disconnect the flexible transmission line and the rigid r-f line section in the r-f unit. If moisture exists, dry all parts of the line thoroughly before reassembling. See paragraph 59a for details on replacing the r-f line.

C. SYMPTOM:

No main pulse or echoes on PPI or Class A oscilloscope, although plate current meter reads normal and sweep lines on both oscilloscopes appear normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Abnormal condition in receiver system.	1. See section VII, Trouble Shooting in Receiver System.
2. Loose or defective coupling in r-f line.	2. Check all couplings for good electrical and mechanical connections.
3. Arc in r-f line between transmitter tube and T-R box.	3. See symptom A above for procedure.

D. SYMPTOM:

No echoes on either oscilloscope, although main pulse appears normal and plate current meter reading is normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Abnormal condition in the receiver system.	1. See section VII, Trouble Shooting in Receiver System.
2. Loose or defective coupling in r-f line.	2. Check all couplings for good electrical and mechanical connections.
3. R-f arc in transmission line between T-R box and antenna probe.	3. See symptom A above for procedure.
4. Defective T-R tube.	4. Replace T-R tube (par. 59c). See also symptom B above, fault No. 2.
5. T-R box out of tune.	5. Check tuning of T-R cavity (par. 37b).
6. Moisture in r-f line.	6. See fault No. 7 under symptom B above.

E. SYMPTOM:

Jumps in echo amplitude with no change in noise on the Class A oscilloscope.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Poor contact in coupler between the r-f unit and the antenna drive unit.	1. Check that parts of the coupler are clean, and that the coupler is drawn together tightly.
2. Poor contact at the inner conductor rotary bearing at coupler between the r-f unit and the antenna drive unit.	2. Check that the fingers are not bent out of shape, and that they make good contact.

F. SYMPTOM:

With Test Set TS-91/TPS-1 (echo box) connected to the probe, the ring-time changes with antenna azimuth position, assuming a particular value for a given antenna position.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. The rotary joint contact varies with position.	1. Check that the inner conductor fingers are not bent out of shape, and that they make good contact.

59. REPLACEMENT OF PARTS.

a. Replacement of Transmission Line Assembly. (1) Remove the T-R box as outlined in subparagraph b below.

(2) From the rear of the r-f unit remove the connection from the probe on the rear section of vertical r-f line (fig. 85).

(3) Remove the magnetron as outlined in paragraph 53e.

(4) From the rear of the r-f unit remove the four screws holding the two clamps (fig. 85) attaching the rear section of vertical r-f line to the wooden support block.

(5) From the front of the r-f unit unscrew the knurled transmission line coupling ring (fig. 84) which is just in front of the magnetron clamping ring.

(6) From the rear of the r-f unit, remove the two nuts holding the angle braces to the top of the vertical support section and remove the four nuts holding the bottom of this vertical support to the metal frame.

(7) Tilt the vertical section forward at the top and pull the r-f line forward and out of the sleeve coupling of the magnetron housing.

(8) Tilt the transmission line assembly outward at the bottom and back at the top, allowing the rear vertical section to drop slightly and work the entire section forward through the opening above the magnetron housing.

(9) To replace, reverse the above steps.

b. Replacement of T-R Box. (1) Disconnect the output loop connection on the rear of the T-R box (fig. 85).

(2) Remove the four screws clamping the T-R box to the horizontal section of transmission line (fig. 32).

(3) The T-R box is now free and can be removed from the front of the r-f unit by bringing it forward and to the right, through the space between the potentiometer box and the vertical section of r-f line.

(4) The T-R box can now be disassembled as shown in figure 33.

(5) To replace the T-R box, reverse the above steps.

c. Replacement of T-R Tube 1B23 (fig. 93).

(1) In removing and handling the T-R tube always be careful not to touch the glass envelope portion or the fin. Handle it by the metal base portion of the tube.

(2) If the T-R box is located in positions 21, 22, or 23, loosen the four clamping screws and move the box toward positions 24 and 25. If it is located at positions 24 or 25, proceed to the next step.

(3) Remove the knurled sleeve located on the axis of the cylindrical portion of the box.

(4) Remove the tube by carefully pulling it outward from the T-R box.

(5) To replace the tube, place the knurled sleeve over the base of the tube and insert the glass envelope end of the tube into the opening in the T-R box.

(6) Carefully guide the sleeve and tube so as not to bend the fin.

(7) Start the sleeve screw.

(8) Push the tube in until the ball electrode seats in the connector, and the fin stops further movement.

(9) Screw in the knurled sleeve and tighten it by hand.

(10) If a new 1B23 tube is installed, retune the T-R box following the procedure in paragraph 37b. It should be necessary to tune only

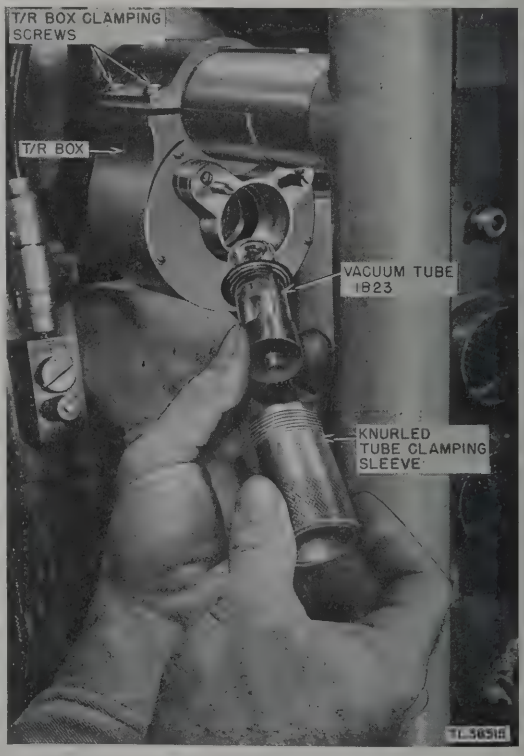

Figure 93. Removing T-R tube.

the T-R box and the inner cavity of preamplifier No. 1 for maximum ringtime. Refer to paragraph 37c for procedure in tuning of inner cavity of preamplifier No. 1.

d. Replacement of Potentiometer Box (fig. 32). (1) Loosen the winged nut on the front of the box, and remove the cover of the box. The interior of the box is now open and the cord connections are accessible.
(2) Mark the cords to identify their connections and remove them from their terminals.
(3) From the rear of the r-f unit remove the four screws holding the box to the upright support panel.
(4) To replace the potentiometer box, reverse the above procedure.

e. Replacement of R-F Unit Blower Assembly (fig. 94). (1) Disconnect the two wires furnishing power to the blower.
(2) Remove the four screws holding the blower support section to the frame.
(3) To replace, reverse the above procedure.

60. TESTING THE T-R BOX.

a. General Information. The following tests can be used to check the T-R box. Radio-Frequency Unit RF-1/TPS-1 needs to be associated with a Modulator Unit MD-2/TPS-1,

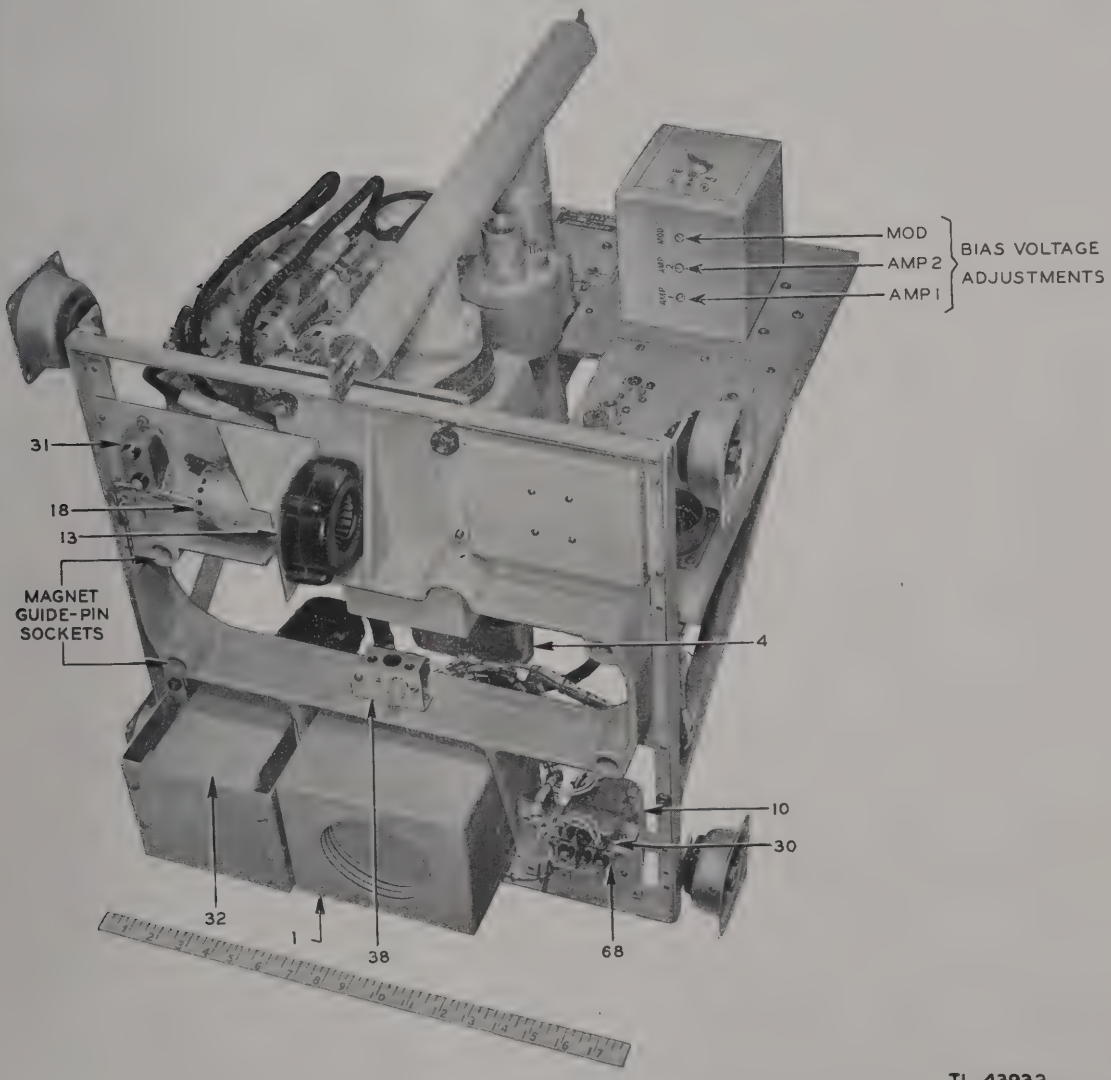

Figure 94. Radio-Frequency Unit RF-1/TPS-1, bottom front view.

and Indicator Unit ID-16/TPS-1A, and a Control Unit C-13/TPS-1 for testing. These auxiliary units may be other than those with which the unit under test is normally associated in a particular system. This may lead to slight differences in performance which are not expected to be significant. In general it is desirable not to erect the units as a tower, particularly when using the probe connection on the dummy antenna. Apparatus designations in general are stamped on or near the part under discussion. Also check against the appropriate schematic diagram, wiring diagram, or assembly drawing.

b. Test Equipment. The following equipment and facilities are required to perform the test described below. Information on special test equipment can be obtained from the handbooks describing such equipment.

(1) Power supply: 400 cycles, 115 volts, 1,250 watts; and 27 volts direct current, 300 watts.
(2) Signal Generator TS-103/TPM-1.
(3) Dummy Antenna TS-105/TPM-1.
(4) Set of connecting cords for Radio Set AN/TPS-1A.

c. T-R Box Measurement. (1) Connect the units of the radio set as for system operation.
(2) Couple the dummy antenna to the transmission line of the radio-frequency unit.
(3) Connect the output from the T-R box, through a 10-db pad, to the input of preamplifier No. 1.
(4) Set the signal generator for operation at the magnetron frequency as determined in paragraph 54d(2). Connect its output to the probe of the dummy antenna through the signal generator attenuator.
(5) Set the attenuator to the minimum-loss position. Tune the beat oscillator with the TUNING control for a maximum meter reading. Check the tuning of the inner cavities of both preamplifiers. Do not change the outer cavity tuning.
(6) Tune the T-R box, as described in paragraph 37b, for a maximum meter reading, always maintaining approximately a 4-volt deflection by GAIN control adjustments. Set the GAIN control for a 4-volt meter reading.
(7) Remove the signal input from the dummy antenna probe and connect it to the input of the first preamplifier. Increase the attenuator reading until the meter again reads 4 volts. The change in attenuation should be equal to the loss in the probe (about 33 db) plus 1.5 to 2.0 db.
(8) A difference greater than 1.5 to 2.0 db requires an examination of the T-R box and its tube. If necessary, replace T-R tube 73.

SECTION VII

TROUBLE SHOOTING IN RECEIVER SYSTEM

WARNING: *Voltages sufficient to cause DEATH ON CONTACT are exposed at many points in this system. The radio-frequency unit operates with peak voltages as high as 20,000 volts. Voltages in excess of 500 volts exist in the radio receiver power supply. Do not make any connections which bring high voltage to an exposed point. Except on specific tests make all tests with the high voltage off. Always short out high-voltage capacitors before touching them or their associated circuits.*

61. REFERENCE DATA.

The following figures are included to assist maintenance personnel in trouble shooting the receiver system.

a. Figure 29, Radio-Frequency Unit RF-1/TPS-1, schematic diagram.

b. Figure 32, Radio-Frequency Unit RF-1/TPS-1, front view.

c. Figure 39, Mixer assembly, disassembled.

d. Figure 40, Receiver system, block diagram.

e. Figure 41, I-f amplifier assembly with cover removed.

f. Figure 42, I-f amplifier assembly, schematic diagram.

g. Figure 44, Indicator Unit ID-16/TPS-1A, front panel.

h. Figure 57, Indicator Unit ID-16/TPS-1A, rectifier circuits, complete schematic diagram.

i. Figure 58, Indicator Unit ID-16/TPS-1A, left side.

j. Figure 59, Indicator Unit ID-16/TPS-1A, schematic diagram complete except for rectifier circuits and i-f amplifier assembly.

k. Figure 65, Resistor color code.

l. Figure 68, Capacitor color code.

m. Figure 69, Test Set TS-91/TPS-1 (echo box), instruction sheet.

n. Figure 71, Echo box ringtime on Class A oscilloscope.

o. Figure 72, Echo box connections for adjustment of mixer.

p. Figure 73, Echo box connections for adjustment of preamplifier No. 1.

q. Figure 74, Echo box connections for adjustment of preamplifier No. 2.

r. Figure 91, Radio-Frequency Unit RF-1/TPS-1, wiring diagram.

s. Figure 92, Radio-Frequency Unit RF-1/TPS-1, right front view.

t. Figure 95, Beat oscillator assembly, tube removed.

u. Figure 96, Removing tube cap from preamplifier No. 1.

v. Figure 97, Removing tube from preamplifier No. 1.

w. Figure 98, I-f amplifier assembly, side view of chassis.

x. Figure 99, Radio-Frequency Unit RF-1/TPS-1, resistances for receiver circuits.

y. Figure 100, Indicator Unit ID-16/TPS-1A, resistances at i-f amplifier assembly mounting, with i-f amplifier assembly removed.

z. Figure 101, Indicator Unit ID-16/TPS-1A, i-f amplifier assembly, wiring diagram.

aa. Figure 102, Indicator Unit ID-16/TPS-1A, i-f amplifier assembly shelf, wiring diagram.

bb. Figure 103, Indicator Unit ID-16/TPS-1A, top and left side view of chassis.

cc. Figure 119, Indicator Unit ID-16/TPS-1A, voltages and resistances of power chassis.

dd. Figure 122, Indicator Unit ID-16/TPS-1A, wiring diagram of power chassis.

ee. Figure 125, Indicator Unit ID-16/TPS-1A, wiring diagram.

62. BEHAVIOR ANALYSIS.

When the receiver system is not operating normally the signals of the PPI and Class A oscilloscopes are of reduced strength, or else the signals do not appear on the oscilloscopes at all. Signals of reduced strength indicate that some part of the receiver system may be detuned or functioning abnormally. Absence of signals and grass indicates that considerable detuning exists or that some part of the circuit is completely inoperative.

a. System Localization. Before attempting to localize the fault within the receiver system, the fault must first be sectionalized to that system. The trouble-shooting procedure outlined in paragraph 41 may have indicated that the receiver is at fault. This may be veried to some extent by turning up the TUNING and GAIN controls (fig. 44) and noting the appearance or lack of appearance of grass on the Class A oscilloscope and of ground echoes on the PPI oscilloscope. The absence of either grass or ground echoes indicates the trouble is in either the receiver or the r-f system.

b. Circuit Localization. Once localized to a particular circuit in the receiver system, troubles may be localized to a defective stage by systematic voltage and resistance measurements. Check all other possible sources of trouble, however, before removing the indicator unit for work on the receiver system.

c. Receiver Power Supply. Power is furnished to the receiver by the power supply in the indicator unit. When tests or observations indicate that trouble exists within the power supply, make a visual inspection first to see if rectifier tubes 348-1 and 348-2 are operating. If the visual check indicates that the tubes are not defective, make voltage and resistance readings and compare them with figure 119 to locate the trouble.

63. RECEIVER SYSTEM, TROUBLE-SHOOTING CHART.

A. SYMPTOMS:

1. Weak signal and weak grass or no signal and no grass.
2. Normal reading on transmitter tube plate current meter.
3. Sweep lines on both oscilloscopes normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper adjustment of GAIN and TUNING controls on front of indicator unit (fig. 44).	1*a*. Rotate GAIN control clockwise to increase receiver gain. *b*. Rotate TUNING control for maximum response, not more than half a turn in either direction. This controls the frequency of the beat oscillator, and therefore the tuning of the receiver. *c*. Check for broken or defective GAIN or TUNING control.
2. Signal channel.	2*a*. Check tubes throughout the signal channel. If they are satisfactory, proceed to next step. *b*. Make voltage and resistance checks throughout the channel, starting at first preamplifier and going through the second detector. Compare readings with those given in figures 42 and 99.

PROBABLE LOCATION OF FAULT	PROCEDURE
3. Gain of one or both preamplifiers is low.	3*a*. Check condition of the GL-446A triode tube. If bad, see paragraph 65c for procedure in replacement of preamplifier tube. Measure voltage at test points AMP 1 and AMP 2 (fig. 32) and ground; reading should be about 1 volt. *b*. Disassemble the cavities and tighten all sliding contacts. See paragraph 65e for procedure in disassembly and reassembly of the preamplifier cavities. *c*. See that the GL-446A tube electrode contacts make good connection with the cavity contacts. *d*. Check the output loop to see if it is damaged or dirty. *e*. See that the input contact makes good connection.
4. Beat oscillator.	4*a*. Using the schematic diagram of the indicator unit (fig. 59), check for broken or loose connections or shorted connections in the beat oscillator circuit. *b*. Check condition of the GL-446A tube. Replace if faulty. See paragraph 65a for procedure in replacement of beat oscillator tube. Measure voltage between test points OSC.+ and OSC.— on the front of the indicator unit. This voltage should not be greater than 2.5 volts. *c*. Tune the beat oscillator as outlined in paragraph 37d. *d*. Disassemble the cavity and tighten all sliding contacts. See paragraph 65b for procedure in disassembly and reassembly of the beat oscillator cavity. *e*. See that the GL-446A tube electrode contacts make good connection with the cavity contacts. *f*. Check the output loop to see if it is damaged or dirty.
5. High conversion loss in the mixer.	5*a*. Check the beat oscillator output with the meter in Test Set TS-91/TPS-1 (echo box) and 30-db pad as indicated on the test set chart (fig. 69). *b*. Check the condition of the GL-446A triode tube. Replace if faulty. See paragraph 65c for procedure in replacement of mixer tube. Measure voltage at MOD test point (fig. 32) and ground; reading should be about 1/2 volt. *c*. Disassemble the mixer cavity and tighten all sliding contacts. See paragraph 65e for disassembly and reassembly of mixer cavity. *d*. Check the input contacts.
6. I-f amplifier assembly (fig. 98).	6*a*. Replace i-f tubes 421-1, -2, -3, -4. See paragraph 65f for procedure in replacement of i-f amplifier assembly. *b*. Check voltages and resistances of i-f stages. *c*. Check for broken or defective connection or shorted connection in the i-f input leads or in the video output leads. *d*. Check for defective I-F OUTPUT or VIDEO INPUT jacks on front panel of the indicator unit (fig. 44). *e*. Check for broken or defective cable connecting the I-F OUTPUT and VIDEO INPUT jacks.

B. SYMPTOM:

Grass on oscilloscopes but no echoes.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Preamplifier No. 1.	1*a*. Examine for loose or shorted connections. *b*. Check tube: replace if defective. See Paragraph 65c for procedure in replacement of preamplifier tube. *c*. Make voltage and resistance checks and compare with those given in figure 99. *d*. Tune preamplifier No. 1 inner and outer cavities according to procedure given in paragraph 37c.
2. Input cable from T-R box to preamplifier No. 1.	2*a*. Check cable for continuity; replace if defective. *b*. Check for broken or defective cable connectors or receptacles.

C. SYMPTOM:

Grass on the Class A oscilloscope disappears; or the baseline wanders.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. A preamplifier may be singing (oscillating).	1*a*. By-pass first one, then the other, to determine which preamplifier is singing. Realign this amplifier according to the procedure in paragraph 37c. It may be that the outer cavity tuning has been altered. *b*. If singing persists, see if there is a short circuit in the input block. *c*. Remove and examine the output loop for damage. See paragraph 65e for procedure in removing and replacing preamplifier. *d*. Replace the GL-446A tube. See paragraph 65c for procedure in replacement of preamplifier tube. *e*. If preamplifier No. 2 is singing, examine the output loop of preamplifier No. 1 and the input block of the mixer. If preamplifier No. 1 is singing, examine the input block of preamplifier No. 2.

D. SYMPTOM:

Intermittent changes in the noise level on the Class A oscilloscope, or jumping of noise level when any cavity is tuned.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Poor contacts in the cavities.	1. Locate and tighten the faulty contacts.

E. SYMPTOM:

Pip amplitude on the Class A oscilloscope does not change when TUNING control is varied.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. TUNING control circuit.	1*a*. Check for faulty TUNING control. *b*. Check for broken or disconnected leads or shorts in the TUNING control circuit.

64. TUNING ADJUSTMENTS.

The echo box may be used for tuning adjustments in the various stages of the receiver system. For these adjustments, use the following references:

a. Tuning preamplifiers, paragraph 37c.

b. Tuning beat frequency oscillator, paragraph 37d.

c. Tuning mixer, paragraph 37e.

d. Receiver line-up, paragraph 37h.

65. REPLACEMENT OF PARTS.

a. Replacement of Beat Oscillator Tube (fig. 95). (1) The beat oscillator tube is located directly behind the front panel TUNING knob and cavity adjusting hole on the indicator unit (fig. 58).

(2) Using a screwdriver in the space between the i-f amplifier assembly and the PPI tube shield, release the screws holding the two straps (fig. 58) over the oscillator assembly.

(3) Remove the socket assembly.

(4) Slide the oscillator assembly away from the front panel to disengage the inner cavity tuning screw from the TUNING knob slotted coupling tube.

(5) Remove the oscillator from its mount and pull off the socket assembly.

(6) Loosen the knurled clamping ring and remove the vacuum tube from the oscillator assembly (fig. 95).

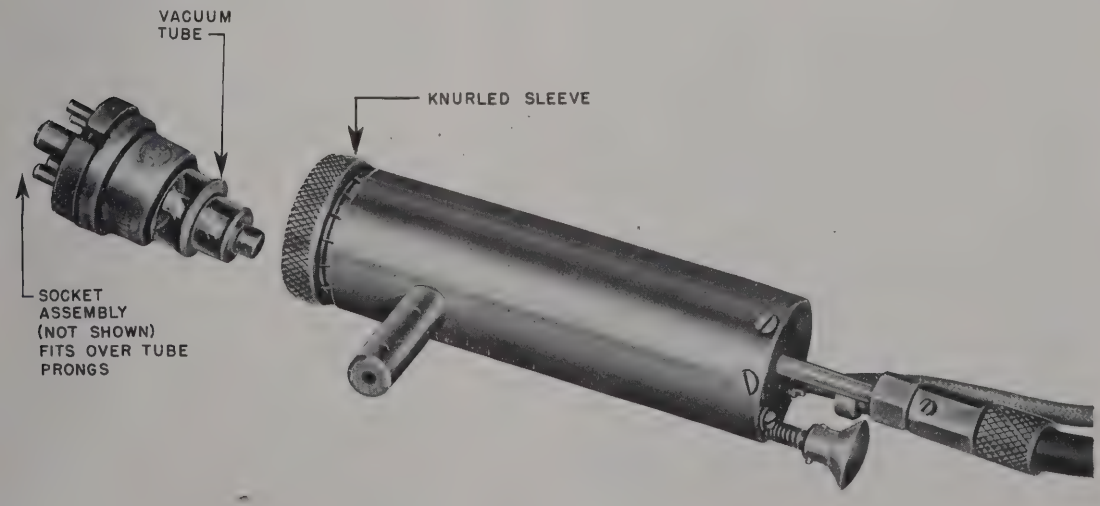

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Figure 95. Beat oscillator assembly, tube removed.

(7) To replace, carefully insert the tube into the end of the oscillator assembly. At the same time rotate the tube slightly to seat it properly, that is, so that the clamp extends over the metal portion of the tube to the shoulder. Align the tube base key with the key slot in the socket, and tighten the knurled clamping ring.

(8) Place the socket assembly over the tube, seating the socket over the vacuum tube pins.

(9) Set the oscillator assembly in its mount and slide toward the front panel, engaging the inner cavity tuning screw with the TUNING knob slotted coupling tube.

(10) Tighten the screws holding the two strap clamps over the oscillator assembly.

(11) Having installed a new GL-446A triode tube, it is necessary to retune the cavities according to procedure given in paragraph 37d.

b. Disassembly and Reassembly of Beat Oscillator Cavity (fig. 95).

(1) REMOVAL OF OSCILLATOR FROM INDICATOR UNIT. (*a*) Uncouple the output coupling loop cord from the 4-db pad.

(*b*) Loosen the two strap clamps which hold the oscillator in its mount. The two fastening screws can be reached with a screwdriver by working in the space between the i-f amplifier and the PPI tube shield.

(*c*) Remove the socket assembly.

(*d*) Move the oscillator assembly away from the front panel to disengage the inner cavity tuning screw from the slotted TUNING knob coupling tube.

(*e*) The oscillator assembly is now free to be moved to make it more accessible. It can, for instance, be moved into the space over the power chassis, where more room can be had by removing tubes.

(2) DISASSEMBLY OF OSCILLATOR.

(*a*) Loosen the knurled vacuum-tube clamping ring and remove the vacuum tube.

(*b*) Gripping the fixed hexagonal part of the assembly to prevent it from rotating, loosen the locking nut on the output loop assembly.

(*c*) Carefully remove the loop assembly from the small tube mount. The loop can now be inspected.

(*d*) Remove the four screws in the outer tube at the end opposite to the knurled clamping ring. Pull off the tube, thus exposing the outer plunger.

(*e*) Loosen the Allen setscrew which fastens the anode filter assembly into the end cap, and pull out the assembly carefully to avoid damaging the feedback finger.

(*f*) Remove the limit screw which is alongside the outer cavity tuning screw (which has the funnel end). Turn the tuning screw clockwise as far as it will go against the end cap, thus releasing the outer plunger. Carefully slide the outer plunger off the inner tube.

(*g*) The contact fingers on the outer plunger now are accessible for inspection.

(*h*) Remove the three screws at the end of the inner tube and pull it off the inner plunger.

(*i*) The contact fingers on the inner plunger now are accessible for inspection.

(3) ASSEMBLY OF OSCILLATOR.

(*a*) Place the inner tube over the anode filter assembly and plate lead. Carefully slide it over the inner plunger until it seats against the shoulder on the end cap. Fasten in place with the three roundhead screws.

(*b*) Place the outer plunger over the anode filter assembly and plate lead and slide the outer plunger over the inner tube, align the tapped hole with the adjusting screw, and rotate the screw counterclockwise to move the plunger toward the end cap. Screw the limit screw into place.

(*c*) Pull the plate lead through the end cap. Then carefully push the anode filter assembly through the center of the inner plunger. Rotate as required to position the feedback finger in the center of the slot of the inner tube, and push through the center hole in the end cap until flush with the outer surface.

(*d*) Clamp in place with the Allen setscrew.

(*e*) Slide the outer tube over the contact fingers of the outer plunger and over the outside of the end cap. Fasten in place with the four flathead screws.

(*f*) Insert the output loop in its tube mount. Rotate it when inserted to insure that it is fully seated in the positioning notch of the mount. Gripping the hexagonal part of the loop assembly to prevent rotation, clamp it in position with the hexagonal locking nut.

(*g*) Insert the vacuum tube, and clamp in place with the knurled ring.

(*h*) Fit the socket assembly to the vacuum tube pins and push into place.

(*i*) Rotate the outer cavity adjusting screw to the end of travel against the limit screw.

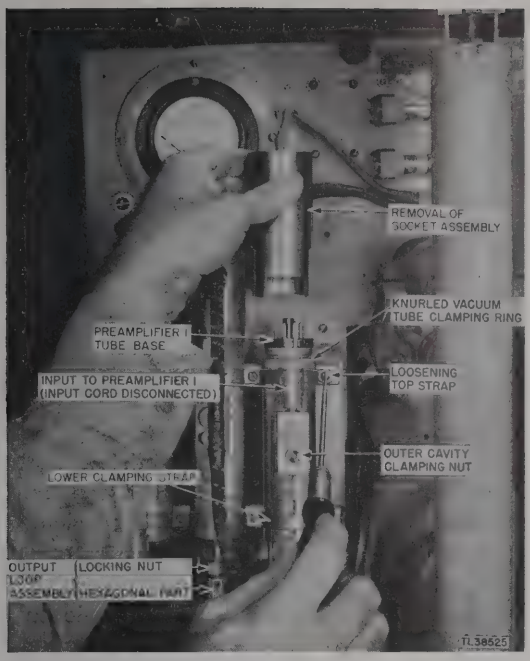


Figure 96. Removing tube cap from preamplifier No. 1.

(*j*) Set the oscillator assembly in place, slipping the inner cavity adjusting screw into the slotted TUNING knob coupling tube. Clamp into place with the two straps.

(*k*) Reconnect the output cord.

(*l*) Retune to the proper frequency as described in paragraph 37d.

c. Replacement of Preamplifier or Mixer Tube (fig. 32). (1) Loosen the top strap which clamps the socket assembly to the mount (fig. 96).

(2) Remove the socket assembly by pulling upwards off the vacuum tube pins (fig. 96). The tube may come out with the socket. If it does not, loosen the knurled vacuum tube clamping ring and remove the tube (fig. 97).

(3) To replace, insert the vacuum tube and locate it so that the base key fits the socket when the cut-out in the socket assembly is positioned to surround the input block.

(4) Clamp the vacuum tube in place by rotating the knurled ring. Tighten this ring until the tube cannot be removed by hand.

(5) Fit the socket assembly to the vacuum tube pins and push into place.

(6) Tighten the top strap clamp.

(7) Retune to frequency of the magnetron, using procedure outlined in paragraph 37c or 37e.

d. Replacement of Preamplifier or Mixer Cavity (fig. 32). (1) Disconnect the input and output cables, and feed the output cable down through the opening beneath the tube.

(2) Gripping the hexagonal part of the assembly to prevent rotation, loosen the locking nut on the output loop assembly. Carefully slip the assembly downward and out of the small mounting tube. Then remove the assembly from the chassis, pulling the cord back through the opening beneath the tube.

(3) Loosen the top strap which clamps the socket assembly to the mount (fig. 96).

(4) Remove the socket assembly by pulling upwards off of the vacuum tube pins (fig. 96). The tube may come out with the socket. If it does not, loosen the knurled vacuum tube clamping ring and remove the tube (fig. 97).

(5) Loosen the lower strap and dismount the assembly.

(6) To replace, insert the output loop in its tube mount. Rotate the output loop when inserted to insure that it is fully seated in the positioning notch of the mount. Gripping the hexagonal part of the loop assembly to prevent

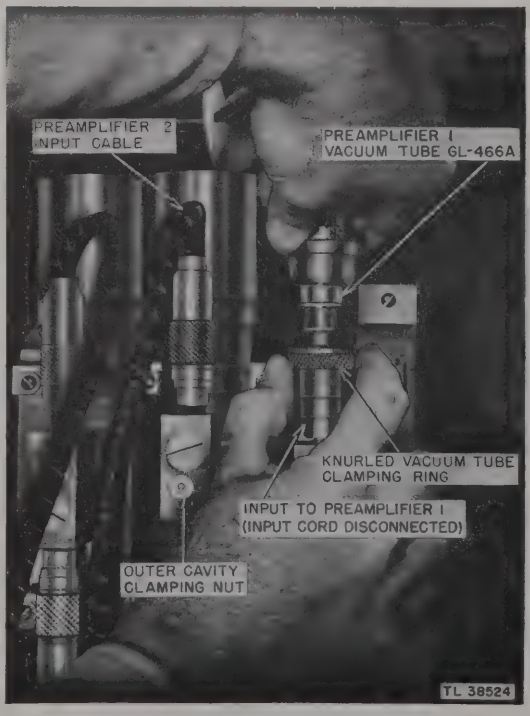

PREAMPLIFIER 2 INPUT CABLE
PREAMPLIFIER I VACUUM TUBE GL-466A
KNURLED VACUUM TUBE CLAMPING RING
INPUT TO PREAMPLIFIER I (INPUT CORD DISCONNECTED)
OUTER CAVITY CLAMPING NUT
TL 38524

Figure 97. Removing tube from preamplifier No. 1.

rotation, clamp the loop in position with the hexagonal locking nut.

(7) Insert the vacuum tube and so locate it that the base key fits the socket when the cut-out in the socket assembly is positioned to surround the input block. Clamp the vacuum tube in place by rotating the knurled ring. Tighten this ring until the tube cannot be removed by hand.

(8) Fit the socket assembly to the vacuum tube pins and push into place.

(9) Mount the amplifier or mixer assembly in the supporting bracket with the two straps. The lower edge of the bottom strap should be flush with the bottom of the assembly.

(10) Reconnect the input and output cords.

(11) Retune to the frequency of the magnetron, using the procedure outlined in paragraph 37c or 37e.

e. Disassembly and Reassembly of Preamplifier or Mixer Cavity. The mixer differs from the preamplifiers in that there is no output loop and no inner plunger; an output filter circuit is enclosed in the inner tube.

(1) REMOVAL FROM R-F UNIT.

(*a*) Disconnect the input and output cables, and feed the output cable down through the opening beneath the preamplifier.

(*b*) Gripping the hexagonal part of the assembly to prevent rotation, loosen the locking nut on the output loop assembly.

(*c*) Carefully slip the assembly downward and out of the small mounting tube, and then remove from the chassis, pulling the cord back through the opening beneath the preamplifier. The loop can now be inspected.

(*d*) Loosen the top strap which clamps the amplifier into the mount.

(*e*) Remove the socket assembly by pulling upwards off of the vacuum tube pins. The vacuum tube may come out with the socket. If it does not, loosen the knurled vacuum-tube clamping ring and remove the vacuum tube.

(*f*) Loosen the lower strap and dismount the amplifier.

(2) DISASSEMBLY OF PREAMPLIFIER OR MIXER. (*a*) Loosen the outer cavity clamping nut, remove the four screws at the base of the outer tube and pull off the tube, thus exposing the outer plunger.

(*b*) Remove the limit screw for the outer cavity tuning screw from the end cap and turn the tuning screw clockwise to the end of travel. The outer plunger assembly is now released from the screw; carefully slide it off the inner tube.

(*c*) The contact fingers on the outer plunger now are accessible for inspection together with the input jack and brush.

(*d*) To reach the inner plunger, remove the three screws at the base of the inner tube. Slide this tube off the end cap and inner plunger, thus exposing the plunger for inspection.

(*e*) If it is necessary to disassemble further, loosen the Allen setscrew in the end cap, and slide the end cap and attached inner plunger off the anode filter assembly and along the plate lead. The contact fingers on the inner plunger can now be reached for inspection.

(3) ASSEMBLY OF PREAMPLIFIER OR MIXER. (*a*) Pull the plate lead through the end cap and carefully slide the anode tube through the center of the inner plunger and into the end cap until it is flush with the outside surface. Clamp in place with the Allen setscrew.

(*b*) Slide the inner tube, holes end first, over the inner plunger, taking care not to damage the contact fingers. Fasten in place over the end cap with the three roundhead screws and lockwashers.

(*c*) Slide the outer plunger assembly over the inner tube, taking care not to damage the contact fingers or the sliding finger contact. Align the adjusting screw with the tapped hole. Rotate the screw counterclockwise to move the plunger toward the end cap. Screw the limit screw into place.

(*d*) Slide the outer tube, with the slot toward the input jack, between the flat spring and the curved strip mounted on the slide, so that the slot straddles the input brush support and the flanged head of the locking screw. Carefully work the tube over the contact fingers of the outer plunger, then over the outside of the end cap. Fasten in place with the four flathead screws.

(*e*) Insert the output loop in its tube mount. Rotate the output loop when inserted to insure that it is fully seated in the positioning notch of the mount. Gripping the hexagonal part of the loop assembly to prevent rotation, clamp the loop in position with the hexagonal locking nut.

(*f*) Insert the vacuum tube and so locate it

that the base key fits the socket when the cut-out in the socket assembly is positioned to surround the input block. Clamp the vacuum tube in place by rotating the knurled ring.

(*g*) Fit the socket assembly to the vacuum tube pins and push into place.

(*h*) Mount the amplifier assembly in the supporting bracket with the two straps. The lower edge of the bottom strap should be flush with the bottom of the amplifier.

(*i*) Reconnect the input and output cords.

(*j*) Retune to the frequency of the magnetron, using the procedure outlined in paragraph 37c or 37e.

f. Replacement of I-f Amplifier Assembly. (1) The i-f amplifier assembly (fig. 98) is located in the top center of the indicator unit (fig. 103).

(2) Disconnect the flexible coaxial cable by unscrewing the knurled connecting ring at the bottom.

(3) Lift the whole amplifier box straight up to disconnect the plug at the bottom.

(4) Expose the five 717A tubes by loosening the three screws on top of the assembly and lifting off the cover.

(5) Unscrew the four screws on the bottom and the two screws on the side of the box.

(6) Lift off the housing in order to expose all wiring and circuit parts of the i-f amplifier assembly.

(7) Replace the i-f amplifier assembly by reversing the disassembly steps above.

66. TESTING OF COMPONENTS.

a. General Information. The following tests can be used to check the individual components of the receiver system. Apparatus designations in general are stamped on or near the part under discussion. Also check against the appropriate schematic diagram or wiring diagram.

b. Test Equipment. (1) The following equipment and facilities are required to perform the tests described below. Information on special test equipment can be obtained from the handbooks describing such equipment.

(*a*) Power supply: 400 cycles, 115 volts, 1,250 watts; and 27 volts direct current, 300 watts.

(*b*) Signal Generator TS-103/TPM-1.

(*c*) Test Unit TS-104/TPM-1.

(*d*) Dummy Antenna TS-105/TPM-1.

(*e*) Line Monitor TS-106/TPM-1.

(*f*) Frequency and Power Measuring Set TS-107/TPM-1.

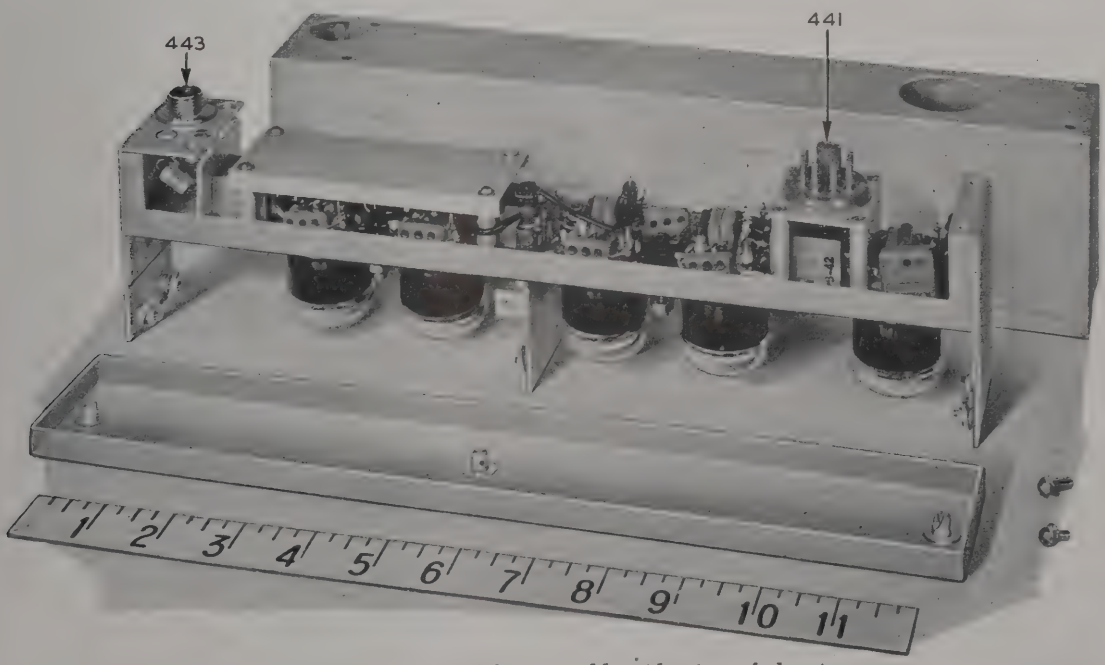


Figure 98. I-f amplifier assembly, side view of chassis. TL 43933

(*g*) Set of connecting cords X-61718K.

(*h*) Signal generator to supply 60 ±5 mc, such as the Ferris Microvolter 18C, modified for 72 ohms output.

(*i*) Test Oscilloscope TS-34/AP.

(*j*) Electrodynamometer type voltmeter: 400 cycles, range to 150 volts.

(*k*) Test Set TS-96/TPS-1 (precision multirange tester, 856P).

(2) In addition to the above items of test equipment, the following parts of Radio Set AN/TPS-1A should be available. These may be parts of the same set as the unit under test, or depot spares, and should be in good operating condition.

(*a*) Set of connecting cords for Radio Set AN/TPS-1A, as listed in table I, paragraph 2.

(*b*) Indicator Unit ID-16/TPS-1A, for use in tests on the receiver circuits.

c. Testing Receiver System. (1) TESTS DESCRIBED. In checking the receiver system the following steps are necessary (subpar. (3) below):

(*a*) Testing the i-f amplifier.

(*b*) Tuning the beat frequency oscillator and measuring its power output.

(*c*) Making a system line-up.

(*d*) Determining the receiver circuit sensitivity.

CAUTION: *IN MAKING THESE TESTS IT IS NECESSARY IN SOME CASES TO REMOVE THE INDICATOR UNIT CHASSIS FROM ITS SHIELD IN TOWER SECTION NO. 2. THIS EXPOSES HIGH-VOLTAGE CIRCUITS, CONTACT WITH WHICH MAY BE DANGEROUS TO LIFE. EXERCISE EXTREME CAUTION WHEN WORKING ON THE UNITS.*

(2) PREPARATIONS FOR TESTING. (*a*) When the indicator unit chassis is removed from its shield, it is necessary to block closed the switch (392-1) at the rear of the unit.

(*b*) For the first three tests, supply power to the indicator unit as follows:

1. Connect one end of blue-coded Cord CX-69/TPS-1, or equivalent, to the power source.
2. Connect the 1-foot blue-coded adapter cord to the other end of Cord CX-69/TPS-1.
3. Connect the blue-coded adapter cord to the input connector on Line Monitor TS-106/TPM-1.
4. Connect the yellow end of the 6-foot cord to the output connector of the monitor, and the blue end to the GENERATOR connector on the indicator unit panel.

(*c*) The line monitor provides means for adjusting the voltage to the indicator unit, as measured at test points on the monitor panel. Adjust and maintain the voltage at 115 volts unless otherwise indicated.

(*d*) With d-c and a-c voltage supplied to the line monitor, d-c power to the indicator unit circuits is controlled by the POWER switch on the indicator unit panel, and a-c power is controlled by a switch on the line monitor and the POWER switch on the indicator unit panel.

(3) TESTS. (*a*) *I-F Amplifier.*

1. Set the voltmeter of Test Set TS-96/TPS-1 to the 12-volt d-c scale and 20,000 ohms per volt. Connect the positive lead to the IF-TST test point on the front panel of the indicator unit and the negative lead to ground (chassis frame).
2. Throw the POWER switch on the indicator unit to ON.
3. Turn the GAIN control on the indicator unit to the extreme counterclockwise position.
4. The voltmeter reading should be between 1-1/2 and 2-1/2 volts.
5. Turn the GAIN control to the extreme clockwise position. Connect a 60-mc signal to the B RF UNIT connector of the indicator unit. Adjust the signal level until the meter reading is about 1 volt higher than it was without the signal. Vary the signal frequency until a maximum voltage is measured on the voltmeter, reducing the signal level as necessary to keep the meter reading below 5 volts. Finally, readjust the signal level to give a 1-volt increase in meter reading over the reading with no signal input.
6. The signal input, to give this 1-volt increase in meter reading, should be between 6 and 20 microvolts.
7. If the amplifier does not meet the above

gain requirement, the cause may be one or more of the following:

(a) Defective tube.
(b) Low plate supply voltage (300 volts normal).
(c) Low heater supply voltage (6.3 volts normal).
(d) Interstage coupling networks out of tune.

8. If retuning of the interstage networks is necessary, use the following procedure.
9. With no signal input, set the GAIN control to obtain 45 volts between the slider of potentiometer 303 and ground. With a signal of 60-mc, apply enough input to the amplifier at the B RF UNIT connector to increase the output voltage 1 volt. Carefully adjust screwdriver tuning controls 435-1 and 435-2 to obtain a maximum output voltage. Readjust the input signal level as necessary to prevent the meter reading from exceeding 5 volts. After the tuning controls are adjusted, vary the signal frequency over a range of 3 mc to either side of the original setting to determine the frequency at which maximum output occurs. This frequency should be 60 ±1 mc. If the frequency of maximum deflection is too low, set the signal frequency to 60.5 mc and repeat the alignment procedure. If the frequency is too high, set the signal frequency to 59.5 mc and repeat the alignment procedure. The frequency of maximum deflection should now fall within 60 ±1 mc.
10. Replace the cover on the amplifier and set the GAIN control to the maximum. Measure the gain as described above. The amplifier should meet the gain requirements.

(b) *Beat Frequency Oscillator.*

1. The beat frequency oscillator should be tuned to a frequency 60 mc below the transmitter frequency. The procedure for tuning the oscillator and measuring its power output is described below.
2. Throw the POWER switch of the indicator unit to ON, and allow a warm-up time of about 10 minutes.
3. Connect one end of the 10-db pad of Frequency and Power Measuring Set TS-107/TPM-1 to the output of the beat oscillator at the green A RF UNIT connector on the indicator unit panel. Connect the other end of the 10-db pad to the frequency and power measuring set through the 1-foot patch cord of the set. Measure the frequency of the beat oscillator. Adjust the tuning of the beat oscillator by turning the TUNING knob (which controls the plunger of the inner cavity) and tracking with the screwdriver-control, outer-cavity tuning screw to obtain a frequency 60 mc below the transmitter frequency. The outer cavity adjustment controls the power output.
4. Connect the frequency and power measuring set for power measurement, and measure the power output of the beat oscillator. The power output measurement should be greater than 11 db. If it is not, see that the outer cavity tuning is adjusted for maximum power output. If the output still is too low, replace vacuum tube 354 and repeat the procedure for tuning and measuring power output.
5. Check the cathode current of the beat oscillator vacuum tube by measuring the voltage between test points OSC +, 396-4, and OSC —, 396-1, which are on the front panel of the indicator unit. The voltage should not be greater than 2.5 volts. If the voltage is greater than 2.5 volts, reduce it by readjusting the outer cavity tuning.
6. If the oscillator has no output, determine that 300 volts is applied to the plate circuit, and 6.3 volts alternating current to the tube heater. Check that the output coupling loop is not open or shorted.
7. If the output is unsteady, the fingers on the tuning plungers may not be making good contact with the cavity walls. Disassemble the cavity and form the fingers to increase the contact. See paragraph 65b for procedure in assembly and disassembly of the beat frequency oscillator.

(c) *Receiver Line-up.*

1. Connect the line monitor between the power supply and the GENERATOR

connector of the indicator unit as described in paragraph 72c(2).

2. Connect the indicator unit and radio-frequency unit with orange-coded interconnecting Cord CX-71/TPS-1.
3. Connect the output of Signal Generator TS-103/TPM-1 through the attenuator to Frequency and Power Measuring Set TS-107/TPM-1 for measuring frequency.
4. Adjust the signal generator controls, as described in its instructions, for maximum power output at the magnetron frequency as measured in paragraph 54d(2).
5. Connect the output of the signal generator through the attenuator to the signal input jack of the mixer.
6. Connect the output of the A RF UNIT jack (beat oscillator output) on the indicator unit to the frequency and power measuring set for measuring frequency.
7. Adjust the TUNING control on the indicator unit panel for maximum power output from the beat oscillator at a frequency 60 mc less than the magnetron frequency.
8. Reconnect the cords between the radio-frequency unit and the indicator unit for system operation.
9. Connect the voltmeter of Test Set TS-96/TPS-1 across resistor 202 in the indicator unit. Bring the voltmeter leads out of the indicator unit chassis through the dust cover so that the unit may be properly seated in the tower section. Set the voltmeter of Test Set TS-96/TPS-1 to read on the 12-volt scale with a resistance of 20,000 ohms per volt.
10. Throw the POWER switch of the indicator unit to the ON position and allow 3 minutes for the apparatus to warm up.
11. Set the GAIN control of the indicator unit to maximum clockwise position.
12. Adjust the attenuator and signal generator output to give a reading of about 4 volts on the Test Set TS-96/TPS-1 voltmeter.
13. Adjust the TUNING control of the indicator unit for a maximum voltmeter reading.
14. Turn the mixer outer cavity tuning screw (input) and the output tuning screw for maximum meter reading.
15. Repeat these tuning adjustments for the maximum meter reading, maintaining the reading at approximately 4 volts by means of the GAIN control of the indicator unit.
16. Remove the signal generator connection from the mixer input, and connect it to the input of preamplifier No. 2.
17. Connect the output of preamplifier No. 2 through a 10-db pad to the signal input of the mixer.
18. Tune preamplifier No. 2 output and input circuits by turning the inner and outer cavity tuning screws, respectively. Obtain a maximum meter reading. It is advisable to tune first the inner cavity tuning screw (output circuit) and then the outer cavity tuning screw (input circuit), repeating the operation several times for a well-adjusted maximum. This reading should be approximately as high as the reading for the mixer alone. If, for example, the meter was adjusted by means of the GAIN control to 4 volts, it should now read at least 3.6 volts. Repeat for preamplifier No. 1, connecting the signal generator to the input of preamplifier No. 1 and a 10-db pad between the output of preamplifier No. 1 and the input of preamplifier No. 2. Remove the pad at the output of preamplifier No. 2.
19. Should the meter reading fail to come up to the required value, indicating an amplifier gain of less than 8 db, replace the GL-446A vacuum tube and make another check. When other attempts to improve the gain fail, take the cavities apart and form all finger contacts to increase their pressure on the cavity walls. Some indication that the plunger finger contacts are bad may be obtained by observing the meter reading when the locknut of the outer plunger is tightened. In general, a change in the meter reading amounting to 1 volt or more indicates poor plunger and finger contacts in the outer cavity.
20. Should a similar change occur when the output structure of the amplifier is

moved slightly, either the contacts of the inner plunger are bad, or the output loop itself is in poor condition.

21. When this test and line-up have been completed and the amplifiers are in good working condition, fasten the input block securely with the outer cavity clamping nut. Do not change this setting, except under testing conditions as just described or as covered in paragraph 37h, when the amplifier is separated from other equipment by 10-db pads.
22. Connect the signal generator through the attenuator to the input of the mixer. Adjust the GAIN control of the indicator unit and the attenuator for a meter reading of 4 volts.
23. Using the frequency and power measuring set, measure the power output of the signal generator as described in the instructions for Frequency and Power Measuring Set TS-107/TPM-1. The attenuation between the signal generator and the mixer being known, the signal input level to the mixer can be determined.
24. Leaving the GAIN control on the indicator circuit at its present position, connect the 60-mc signal generator to the B RF UNIT jack of the indicator unit. Measure the input level in db below 1 milliwatt required to produce the same 4-volt meter reading. The conversion loss is the difference between the 60-mc input level to the B RF UNIT jack and the radio-frequency signal input level to the mixer. This loss should not be more than 10 db.
25. A defective GL-446A vacuum tube or poor contacts may account for an increase in this loss. Check them first, therefore, in looking for any troubles.

(*d*) *Receiver Sensitivity.*

1. Connect the signal generator, tuned to the magnetron frequency, through the attenuator to the probe of the dummy antenna.
2. Connect the complete radio set for system operation. Connect the voltmeter of Test Set TS-96/TPS-1 across resistor 202 in the indicator unit as described in subparagraph (*c*)9 above. Set the signal generator attenuator for minimum loss. With the power on the individual sections of the receiver as in subparagraph (*c*) above, tune the beat oscillator with the TUNING control and the inner plungers of both amplifiers and the T-R box for a maximum meter reading. (This is a recheck of the line-up of subparagraph (*c*) above). Adjust the GAIN control of the indicator unit to maintain a reading of approximately 4 volts. Increase the attenuator reading for maximum loss. The meter should read approximately 2 volts. If it does not, throw the POWER switch of the signal generator to the off position, and observe any change in the meter reading. Should the meter reading remain unchanged, disconnect each of the preampliers in turn to determine whether or not they are singing. If one of the preampliers is at fault, realign the tuning controls as in subparagraph (*c*) above. If the meter reading does change when the signal generator POWER switch is thrown to the off position, check the shielding of the signal generator to be certain that none of its power is being transmitted to the receiver without going through the attenuator and connecting cords.
3. With the attenuator set for maximum loss, and the signal generator operating, increase the gain on the indicator unit until the meter reading increases 1 volt over its residual reading obtained with the GAIN control set at the maximum counterclockwise position. Repeat the tuning of the signal generator and observe any change in the meter reading. (The attenuator is still set at maximum loss position.) If the reading does change, check the shielding of the signal generator.
4. With the GAIN control set in the position just determined, obtain the attenuator setting required to give an additional 1-volt increase in the meter reading. From a knowledge of the output level of the signal generator, the attenuator reading, and the probe loss, the signal input level equal to the noise level may be determined.

Resistance Measurements at Various Points on Radio-Frequency Unit RF-2/TPS-1

Average values calculated from nominal resistance components between the Terminal in Column 1 and the Reference Point in Column 2.

Column 1 *Terminal*	*Column 2* *Reference Point*	*Column 3* *Resistance in Ohms*
Test Point MOD (39-1)	Ground	100
Test Point AMP 1 (39-2)	Ground	100
Test Point AMP 2 (39-3)	Ground	100
Plate of preamp 1 (21-1)	Connector 60, pin P	8,600
Plate of preamp 2 (21-2)	Connector 60, pin P	8,600
Plate of mixer (22)	Connector 60, pin P	14,000

Resistance Measurements at Vacuum Tube Socket Terminals Radio-Frequency Unit RF-2/TPS-1

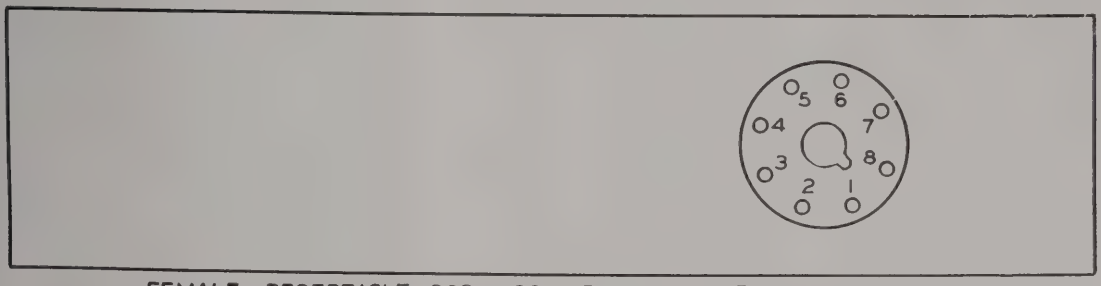
Average values calculated from nominal resistance components between the Socket Terminal in Column 1 and the Reference Point in Column 2.

Column 1		*Column 2*	*Column 3*
Tube Socket	*Terminal*	*Reference Point*	*Resistance in Ohms*
23-1	1	Ground	0
	2	Ground	0
	3	Ground	145, when MOD pot is counterclockwise, 1647 when clockwise.
	4	Ground	∞
	5	Ground	Same as term 3
	6	Ground	∞
	7	Ground	0
	8	Ground	Same as term 3
23-2	1	Ground	0
	2	Ground	0
	3	Ground	145 when 2nd AMP pot is counterclockwise, 745 when clockwise.
	4	Ground	∞
	5	Ground	Same as term 3
	6	Ground	∞
	7	Ground	0
	8	Ground	Same as term 3
23-3	1	Ground	0
	2	Ground	0
	3	Ground	145 when 1st AMP pot is counterclockwise, 745 when clockwise.
	4	Ground	∞
	5	Ground	Same as term 3
	6	Ground	∞
	7	Ground	0
	8	Ground	Same as term 3

Figure 99. Radio-Frequency Unit RF-1/TPS-1, resistances for receiver circuits.

5. Noise level equals attenuator reading plus probe loss minus signal generator level in db above 1 milliwatt. This noise level should be at least 88 db below 1 milliwatt.

6. Any difference from this requirement is usually due to the operation of the pre-amplifiers. These should, therefore, be checked in attempting to locate any trouble.



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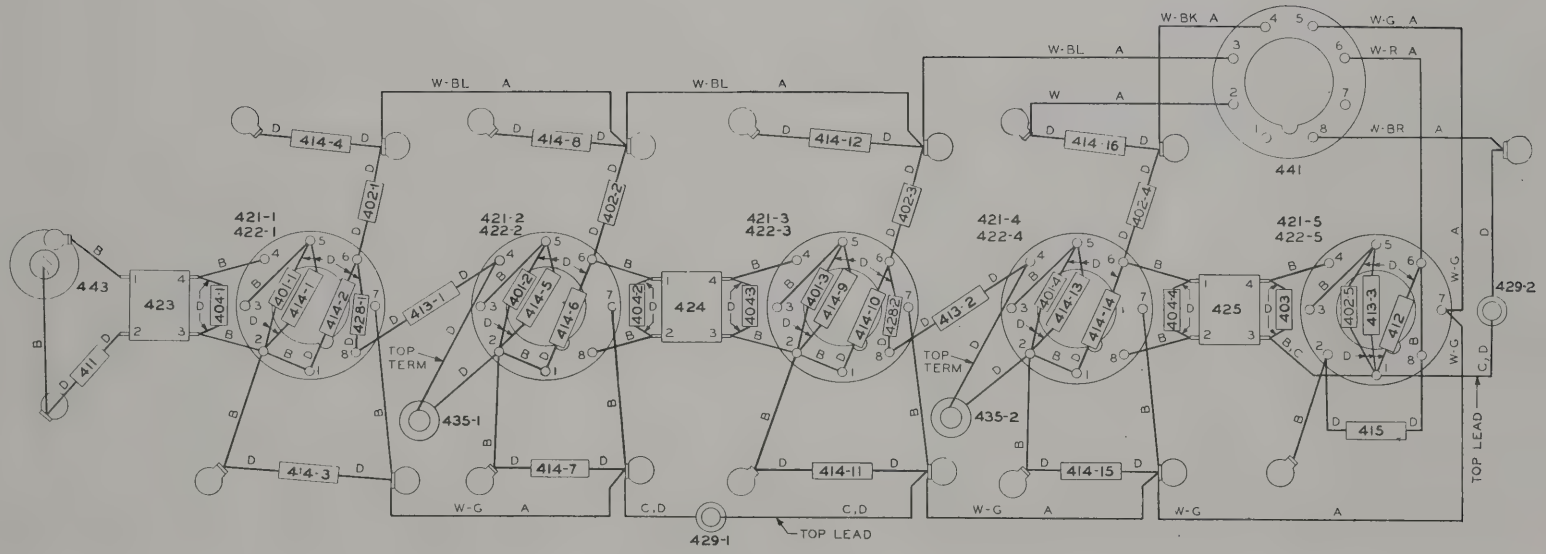
Resistance Measurements at Vacuum Tube Socket and Equipment Terminals

I-F Amplifier Connector Socket

Measure				
From		*To*		
Equipment	*Terminal*	*Equipment*	*Terminal*	*Resistance in Ohms*
382	2		A2	0
382	3		A2	0-4700
382	4	382	6	5000
382	5		A1	0
382	6		A2	5500
382	8		A3	4
382	4		A4	5300

Figure 100. Indicator Unit ID-16/TPS-1A, resistances at i-f amplifier assembly mounting, with i-f amplifier assembly removed.



LEAD DESIGNATION	DESCRIPTION
A	NO. 20 A.W.G STRANDED WIRE PER KS-8640
B	NO. 20 A.W.G BARE TINNED WIRE
C	COVERED WITH NO. 20 BLACK VARNISHED TUBING PER LRM-186
D	FURNISHED WITH APPARATUS

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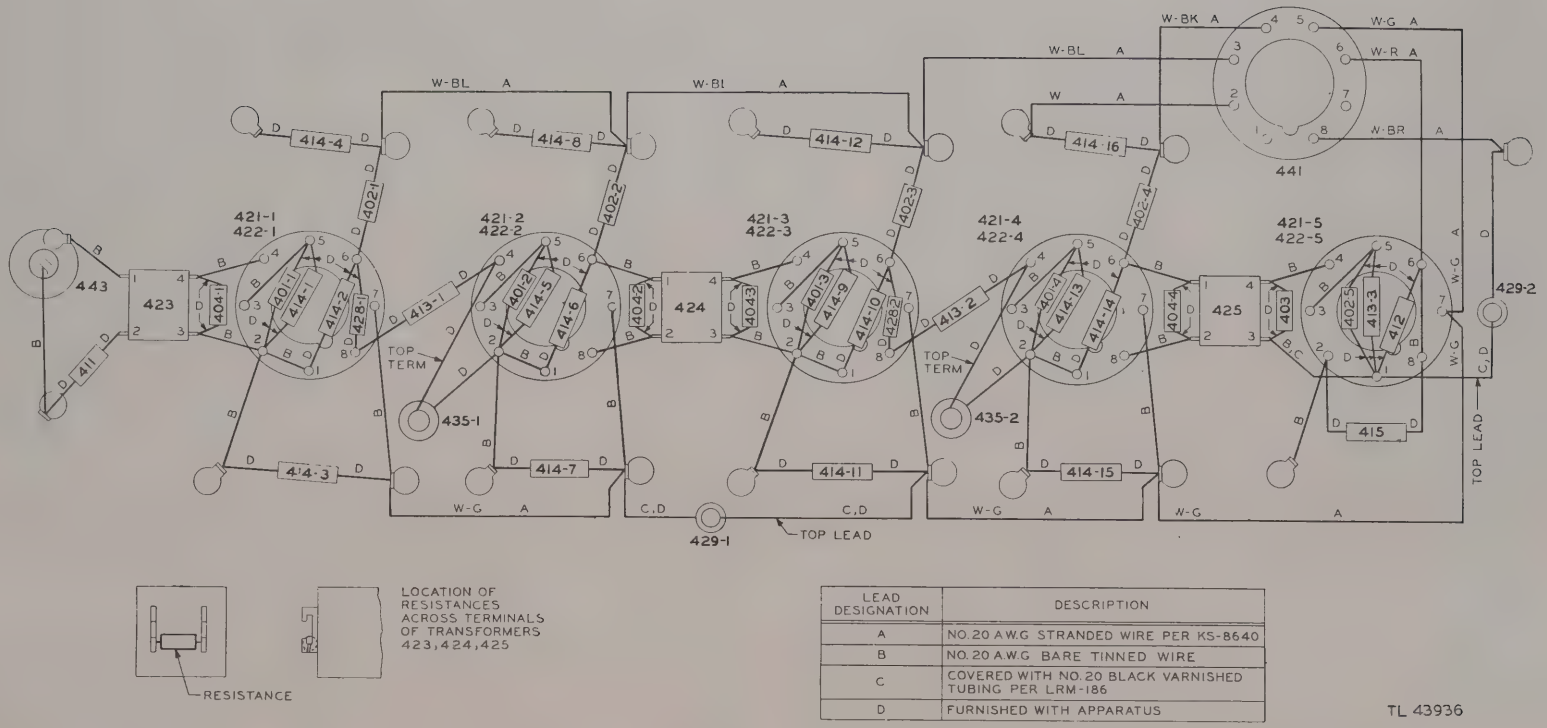
Figure 101. Indicator Unit ID-16/TPS-1A, i-f amplifier assembly, wiring diagram.

Figure 102. Indicator Unit ID-16/TPS-1A, i-f amplifier assembly shelf, wiring diagram.



LEAD DESIGNATION	DESCRIPTION
A	NO. 20 A.W.G STRANDED WIRE PER KS-8640
B	NO. 20 A.W.G BARE TINNED WIRE
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D	FURNISHED WITH APPARATUS

TL 43936

Figure 101. Indicator Unit ID-16/TPS-1A, i-f amplifier assembly, wiring diagram.

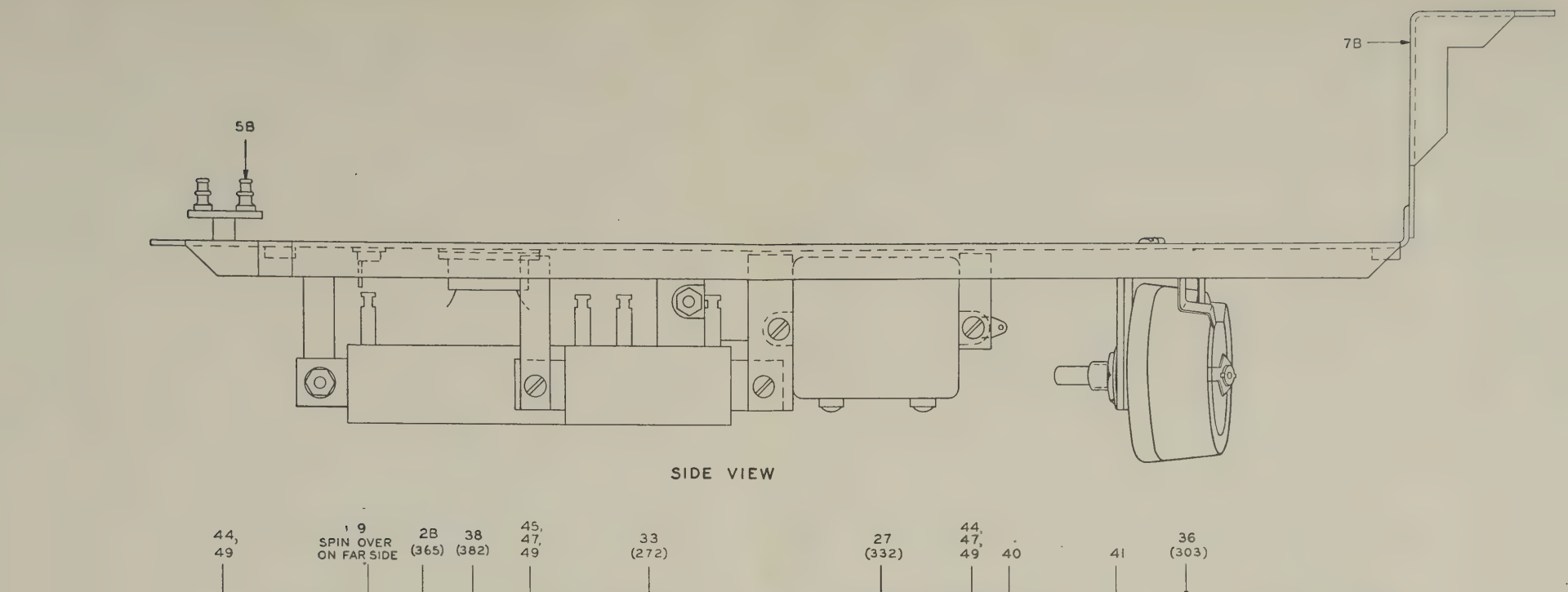


Figure 102. Indicator Unit ID-16/TPS-1A, i-f amplifier assembly shelf, wiring diagram.

SECTION VIII

TROUBLE SHOOTING IN INDICATOR SYSTEM

WARNING: *Voltages sufficient to cause DEATH ON CONTACT are exposed within Indicator Unit ID-16/TPS-1A. Do not put hands or arms within the indicator unit while the high voltage is on. Do not make any connections into the unit which bring high voltages out to an exposed point. If it is necessary to measure voltages within the unit, turn all power off, connect the voltmeter, and turn the power on. Do not handle the voltmeter or leads when the power is applied.*

67. REFERENCE DATA.

The following figures are supplied to assist maintenance personnel in trouble shooting in the indicator system.

a. Figure 44, Indicator Unit ID-16/TPS-1A, front panel.

b. Figure 45, Indicator system, simplified block diagram.

c. Figure 46, Indicator system, complete block diagram.

d. Figure 47, Class A and PPI oscilloscope circuits, simplified schematic diagram.

e. Figure 48, Indicator Unit ID-16/TPS-1A, left side view of chassis.

f. Figure 49, Indicator Unit ID-16/TPS-1A, right side view of chassis with cover of high-voltage rectifier compartment removed.

g. Figure 50, Class A and PPI prepulser circuits, simplified schematic diagram.

h. Figure 51, Sweep circuit waveforms.

i. Figure 52, Class A and PPI sweep generator circuits, simplified schematic diagram.

j. Figure 53, Class A sweep amplifier circuit, simplified schematic diagram.

k. Figure 54, PPI sweep amplifier circuit, simplified schematic diagram.

l. Figure 55, Range marker circuits, simplified schematic diagram.

m. Figure 56, Video amplifier circuits, simplified schematic diagram.

n. Figure 57, Indicator Unit ID-16/TPS-1A, rectifier circuits, complete schematic diagram.

o. Figure 58, Indicator Unit ID-16/TPS-1A, left side.

p. Figure 59, Indicator Unit ID-16/TPS-1A, schematic diagram complete except for rectifier circuits and i-f amplifier assembly.

q. Figure 65, Resistor color code.

r. Figure 68, Capacitor color code.

s. Figure 103, Indicator Unit ID-16/TPS-1A, top and left side view of chassis.

t. Figure 104, Indicator Unit ID-16/TPS-1A, rear view of chassis.

u. Figure 105, Deflection coil, slip rings, gears, and contact springs.

v. Figure 106, Indicator Unit ID-16/TPS-1A, right side showing parts involved in replacement of focusing and centering coil assembly.

w. Figure 107, Indicator Unit ID-16/TPS-1A, PPI oscilloscope tube removed.

x. Figure 108, Indicator Unit ID-16/TPS-1A, right side showing parts involved in replacement of PPI drive gears and mechanism.

y. Figure 109, Indicator Unit ID-16/TPS-1A, bottom view of chassis.

z. Figure 110, Indicator Unit ID-16/TPS-1A, test waveforms for tubes 352-1 and 351-3.

aa. Figure 111, Indicator Unit ID-16/TPS-1A, test waveforms for tubes 351-2, 351-4, and 351-6.

bb. Figure 112, Indicator Unit ID-16/TPS-1A, test waveforms for tubes 352-2 and 351-7.

cc. Figure 113, Indicator Unit ID-16/TPS-1A, test waveforms for tubes 352-5 and 350-1.

dd. Figure 114, Indicator Unit ID-16/TPS-1A, test waveforms for tube 352-3.

ee. Figure 115, Indicator Unit ID-16/TPS-1A, test waveforms for tubes 351-8 and 352-6.

ff. Figure 116, Indicator Unit ID-16/TPS-1A, resistances at Class A oscilloscope tube socket.

gg. Figure 117, Indicator Unit ID-16/TPS-1A, voltages and resistances of video and sweep chassis.

hh. Figure 118, Indicator Unit ID-16/TPS-1A, voltages and resistances of range marker chassis.

ii. Figure 119, Indicator Unit ID-16/TPS-1A, voltages and resistances of power chassis.

jj. Figure 120, Indicator Unit ID-16/TPS-1A, wiring diagram of video and sweep chassis.

kk. Figure 121, Indicator Unit ID-16/TPS-1A, wiring diagram of range marker chassis.

ll. Figure 122, Indicator Unit ID-16/TPS-1A, wiring diagram of power chassis.

mm. Figure 123, Indicator Unit ID-16/TPS-1A, wiring diagram of Class A insulator assembly.

nn. Figure 124, Power connector, wiring diagram.

oo. Figure 125, Indicator Unit ID-16/TPS-1A, wiring diagram.

68. BEHAVIOR ANALYSIS.

a. General. (1) The indicator system of Radio Set AN/TPS-1A may be divided, for trouble-shooting purposes, into ten distinct circuits:

(*a*) The PPI sweep circuit.
(*b*) The Class A sweep circuit.
(*c*) The PPI video circuit.
(*d*) The Class A video circuit.
(*e*) The PPI oscilloscope circuit.
(*f*) The Class A oscilloscope circuit.
(*g*) The high-voltage rectifier circuit.
(*h*) The positive 300-volt-regulated and negative 150-volt power supply circuit.
(*i*) The AZIMUTH control and PPI sweep coil circuit.
(*j*) The electronic range markers circuit.

(2) When trouble has been traced to the indicator system, make the following checks to localize the defect to a particular circuit within the system.

b. Localizing Trouble to a Particular Circuit. (1) VISUAL INDICATIONS. The power for the indicator system is supplied by the power supply within the indicator unit chassis. To determine if the power unit is defective, several visual indications are useful. Note whether the PPI dial lights are lit; if so, 115 volts alternating current is being supplied to the high-voltage rectifier and consequently to the unit. Remove the indicator unit from the tower section, depress the safety switch in the rear of the unit, and observe voltage regulator tubes 353-1 and 353-2. These tubes should glow with a blue haze. Lack of this visual indication means some difficulty with the +300-volt and —150-volt regulated power supply circuit. The regulator tube which is not glowing will indicate which section of the power supply is at fault. There is a possibility that the 5,000-volt high-voltage rectifier circuit is defective. Trouble in this circuit will result in loss of intensity on the PPI oscilloscope and complete failure of the trace if the voltage drops to a low value or fails completely. If it is necessary to check this power supply, make resistance measurements with the power *off*.

(2) WAVEFORMS. If the power supply circuits have been found satisfactory by visual check, the next step in the trouble-shooting procedure is to determine whether the defect lies in a sweep channel. Waveform analysis can best be used for this purpose. Check the input and output waveforms as seen on a test oscilloscope against the waveforms shown in figures 112, 113, 114, and 115. The input waveform, a positive trigger pulse, can be taken at pin 4 of either prepulser tube 352-2 or 352-3 in the indicator unit. The output waveform, a sawtooth voltage, can be taken at the plate of the sweep amplifier tube of the sweep circuit at fault. These test points may be easily located by referring to the schematic diagram of the indicator unit (fig. 59). Check also the blanking waveforms at terminal V15 on the video and sweep chassis and at V12 on the terminal strip on the video and sweep chassis. Each of these waveforms should be a positive steep-sided square wave. If all these waveforms are correct, the sweep circuits may be considered in satisfactory operating condition. The fault will then lie in the PPI or Class A oscilloscope or its associated circuit. If the input pulse to the sweep circuits is incorrect, check the orange cable between the indicator unit and the r-f unit. Check also input receptacle 381. If the input waveform is correct and the output waveform is incorrect, the sweep circuit is defective.

(3) VOLTAGE CHECKS. Although the visual indications help determine whether the power supply circuits are defective, faulty visual indications do not necessarily mean the fault lies within the power unit. The PPI dial lights may be burned out. Wiring in the dial lights circuit may be broken or defective. Also, no check has been made on the power supply plate-voltage outputs. Therefore, if the fairly simple usual checks and waveform checks do not help trace the difficulty to a particular channel, perform the following voltage checks to determine definitely whether the power unit is defective. The output voltage of the power supply can be read at the terminal board at the bottom of the power chassis subsection of the indicator unit. Be sure the safety switch in the rear of the indicator unit is held in while making the following checks.

(*a*) Measure the —150-volt output at terminals P11 and ground.

(*b*) Measure the +300-volt output at terminals 300V and GND adjacent to potentiometer control 291-1 near the left-hand edge of the power chassis of the indicator unit (fig. 103).

c. Localizing Trouble to a Particular Stage. (1) GENERAL. The preceding series of checks and tests has helped the maintenance man localize the trouble to a particular circuit within the indicator system. The following information is offered to help the maintenance man localize the trouble to the particular stage or stages within the unit which may be responsible for the defect.

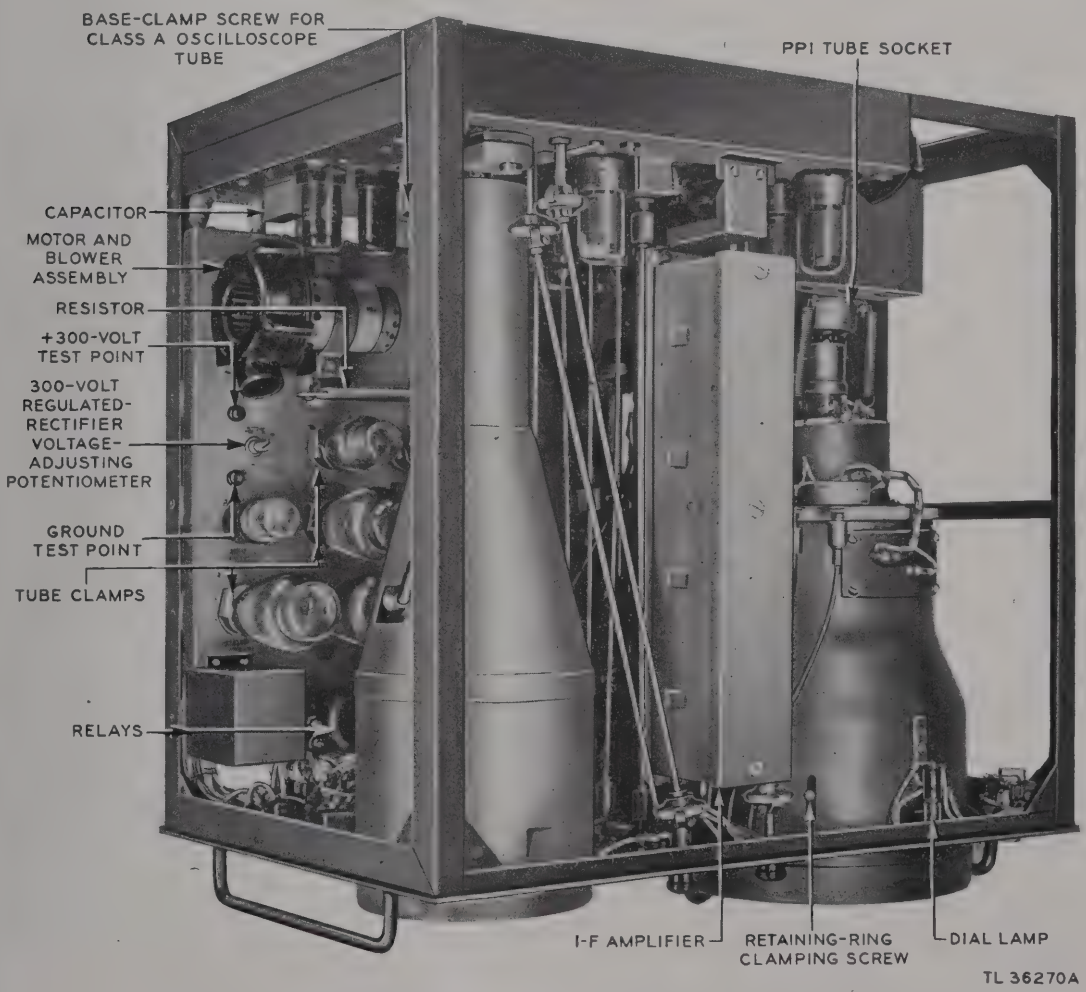


Figure 103. Indicator Unit ID-16/TPS-1A, top and left side view of chassis.

(2) POWER SUPPLY CIRCUITS. The best way of checking the power supply circuits is by means of resistance measurements with the power off. Make sure that the two VR tubes 353-1 and 353-2 are securely in place, since the entire regulated power supply will be shut down and remain inoperative if any one of these tubes is out of place. To locate the defective part or parts within the power supply, proceed to take the necessary resistance measurements as described in section I of this chapter for a typical rectifier circuit. Should voltage measurements be necessary, be *careful.* The output of the high-voltage rectifier can be measured indirectly by measuring the voltage drop across the first of the bleeder resistors. The voltage drop across resistor 280 should be approximately +1,500 volts. The output of a step-down winding on transformer 363 provides filament voltage to all tubes in the indicator unit except those in the power supply itself. This output can be checked at terminal P4 on the terminal strip on the bottom of the power chassis. No output here indicates defective windings on transformer 363 or an open fuse A. Check the a-c input to the power chassis at terminal P17 on the terminal strip on bottom of the power chassis. The +300 and —150 voltage supplies can be measured at terminals P7 and P11 respectively. If a proper reading is not obtained, check the parts within the circuit (fig. 57). The voltage of the regulated +300-volt supply should be adjusted to +300 volts. Potentiometer control 291-1 for this adjustment is located near the left-hand edge of the power chassis (fig. 103). The voltage is measured with a voltmeter between the test points marked 300V and GND which are adjacent to this potentiometer control. This control and the test points are not accessible unless the indicator unit is removed from the tower section.

(3) SWEEP CIRCUITS. The best way of checking the sweep circuits is by means of waveforms. The input of each stage is shown in figures 112, 113, 114, and 115. Place the test lead of the oscilloscope at the proper tube socket pin, and note the waveform. Begin with the triggering pulse of the circuit and work toward the output sawtooth waveform of that circuit. When a stage is reached where the waveform indicates a defect, take the necessary voltage or resistance measurements (fig. 117) to pick out the part or parts responsible for the defective operation. Be sure to test the tube of the defective stage.

(4) PPI OSCILLOSCOPE CIRCUIT.

WARNING: *Be careful.* A potential of 5,000 volts exists at the high-voltage anode attached to the glass envelope of this cathode-ray tube. Observe the warning at the head of this section. Should voltage checks be made, be sure that the power is *off* when connecting the voltmeter. Do not handle the voltmeter or leads while the power is applied.

(*a*) When trouble is localized to the PPI oscilloscope or its associated circuits and no sweep trace appears, examine the high-voltage cord to the high-voltage anode of the oscilloscope and the rubber-covered connector to make sure that adequate contact is made to the glass envelope of the cathode-ray tube.

WARNING: MAKE SURE THE POWER IS OFF.

Advance the BRIGHTNESS control to see if this adjustment will produce a visible trace.

(*b*) To check that input waveforms are correct in the PPI oscilloscope circuit, compare each waveform as seen on a test oscilloscope with the corresponding waveform shown in figure 113. The input waveform at terminal V12 of the terminal strip on the video and sweep chassis is a sweep trace showing transmitter pulse and probable target echoes similar to the picture on a typical Class A oscilloscope. A sawtooth voltage waveform can be taken at terminal V11 of the terminal strip on the video and sweep chassis. If these waveforms are satisfactory, examine the waveforms at the socket of the PPI oscilloscope tube. The video pulses can be tested at pin No. 5. Make sure that the positive, unblanking, steep-sided square wave exists on the grid (pin No. 3) of the PPI tube. If this square wave does not exist, examine the connectors and cords for tightness of connections. If necessary, check the continuity of the cords. In a similar manner, using voltage or

resistance measurement, trace the defect to the part or parts within the PPI oscilloscope circuit responsible for the trouble. Voltage and resistance measurements for the PPI oscilloscope circuit may be checked by means of figures 57, 59, and 119.

(5) CLASS A OSCILLOSCOPE CIRCUIT.

WARNING: *Be careful.* A potential of approximately —1,200 volts exists at the cathode of the Class A oscilloscope tube and potentials of approximately +1,500 volts on the anode attached to the glass envelope of the tube. Observe the warning at the head of this section. Be sure the power is *off* before connecting a voltmeter. Do not handle the voltmeter or leads when power is applied. Keep clear of the rubber-covered connector on the side of the tube when power is on.

(*a*) When trouble is localized to the Class A oscilloscope or its associated circuit and no trace appears, examine the high-voltage cord connecting to the side of the oscilloscope and the rubber-covered connector to make sure that adequate contact is made to the glass envelope of the tube.

WARNING: MAKE SURE THE POWER IS OFF WHEN EXAMINING THE HIGH-VOLTAGE CORD.

Advance the BRIGHTNESS control to see if this adjustment will produce a visible trace.

(*b*) To check that input waveforms are correct in the Class A oscilloscope circuit, compare each waveform as seen on a test oscilloscope with the corresponding waveforms shown in figure 115. The input waveform at terminal V16 on the video and sweep chassis of the indicator unit is a sweep trace showing transmitter pulse and probable target echoes similar to the picture obtained on any typical Class A oscilloscope. A saw-tooth voltage waveform can be taken at either plate of the final Class A sweep amplifier (pins No. 2 and No. 5 of tube 352-6). If these waveforms are satisfactory, examine the waveforms at the socket of the Class A oscilloscope tube. The video pulse can be tested at pin No. 7. Make sure that the positive, unblanking, steep-sided square wave exists on the grid (pin No. 3). If this square wave does not exist, examine the connectors and cords for tightness of connections. If necessary, check the continuity of the cords. In a similar manner, using voltage and resistance measurements, trace the defect to the part or parts within the Class A oscilloscope circuit responsible for the trouble. Voltage and resistance measurements may be checked by means of figures 57, 59, and 119.

(*c*) It is possible to use the Class A oscilloscope as a test oscilloscope in checking the waveforms of other circuits. In many cases this arrangement is easier and faster than connecting a test scope. When the Class A oscilloscope is used for this purpose it must first be determined definitely that the trouble is not in the Class A oscilloscope circuit or in the sweep circuit of this oscilloscope. In other words, the modulator unit must be working properly, the input transformer of the r-f unit must be satisfactory, and the positive trigger pulse must be applied to the sweep circuit of the Class A oscilloscope. Then this oscilloscope can be used as a test instrument to locate trouble in both the PPI and Class A oscilloscope video circuits, the range marker circuit, and the PPI oscilloscope sweep circuit. All of these circuits are in the indicator unit. To connect the Class A oscilloscope as a test instrument, first disconnect the VIDEO INPUT cable on the indicator unit panel, then connect a test lead to the + PULSE jack on the left-hand side of the indicator unit panel, and apply the probe of this test lead to the check point of the circuit under observation. If the signal being tested is too weak to give suitable deflection on the Class A oscilloscope, the test lead may be inserted into the VIDEO INPUT connection instead of the + PULSE jack.

(6) AZIMUTH CONTROL AND PPI SWEEP COIL CIRCUIT. The AZIMUTH control may be rotated as required after raising the lock bar and pressing the knob inward. It controls the angular position of radial sweep of the PPI oscilloscope, permitting correlation of sweep direction and antenna position. For trouble shooting the operation of this mechanical circuit see step 6 of section III, Trouble Shooting Based on Starting Procedure, and paragraphs 70b, 71d, and 71e of this section.

69. INDICATOR SYSTEM, TROUBLE-SHOOTING CHART.

A. SYMPTOM:
Fuse A blows.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Faulty fuse.	1. Replace fuse. If second fuse blows, proceed to next step.
2. Filament supply circuit.	2*a*. Check for grounds on filament supply to tubes 351-1, 351-2, 352-2, 352-4, 351-7, 352-5, 350-1, 347, 352-6, 351-8, 352-3, 351-6, 351-5, and socket 382. *b*. Check that filament choke 366-2 is not grounded on can cover. *c*. Check with ohmmeter for grounded point in primary of high-voltage transformer. This is transformer 359 or 360 (par. 24c).
3. PPI dial light circuit.	3. Check that PPI dial light circuit is not grounded.

B. SYMPTOM:
Fuse B blows.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Faulty fuse.	1. Replace fuse. If second fuse blows, proceed to next step.
2. The +500-, +300-, or —150-volt power supply.	2*a*. Check with ohmmeter for a grounded point in one of these power supplies. Refer to the schematic diagram of the indicator unit (fig. 59) and check with ohmmeter until grounded point is located. *b*. Check with ohmmeter for grounded point in primary of transformer 361 or 362.
3. Blower motor circuit.	3. Check with ohmmeter for a grounded point in blower motor 700 or thermostat 720 circuit.

C. SYMPTOMS:
1. No sweep on either PPI or Class A oscilloscope.
2. Plate current meter on r-f unit reads normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper adjustment of BRIGHTNESS controls.	1. Turn up BRIGHTNESS controls for each oscilloscope to see if this gives sweep line on either or both oscilloscopes.
2. Control system.	2. See step 4 of section III, Trouble Shooting Based on Starting Procedure.

PROBABLE LOCATION OF FAULT	PROCEDURE
3. Transmitter system.	3. Check waveform at pin No. 4 of either tube 352-2 or 352-3 and see if the positive trigger pulse is present. If it is not, the trouble is either in the transmitter system or the wiring. See symptom C in section V, Trouble Shooting in Transmitter System. It is unlikely that a trouble would develop simultaneously in both the PPI oscilloscope and the Class A oscilloscope sweep circuits, but if the above checks do not locate any trouble, refer to symptoms D and E below for procedure in locating troubles in the PPI oscilloscope and Class A oscilloscope sweep circuits.

D. SYMPTOMS:

1. No sweep line or ground echoes on PPI oscilloscope, or abnormal appearance of sweep line or ground echoes.
2. Class A oscilloscope sweep line and grass appear normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper adjustment of PPI BRIGHTNESS control.	1. Turn up PPI BRIGHTNESS control.
2. PPI oscilloscope circuit.	2*a*. Adjust PPI FOCUS, HOR CENT, and VERT CENT to try to obtain proper scope picture. *b*. Using the Class A oscilloscope as a test scope by inserting a test lead in the + PULSE jack on the indicator unit panel, check for a sawtooth waveform at terminal 2 of deflecting coil assembly 333. If present, proceed to next step. *c*. Check the —150, +5,000, +500, and +300 power supply voltages. See paragraphs 68b(1), 68b(3), and 68c(2) of this section. *d*. Take voltage and resistance measurements at the socket of the PPI tube and refer to figures 57, 59, and 119 to locate the faulty circuit component.
3. PPI oscilloscope sweep circuit.	3*a*. Check tubes 352-2, 351-7, 353-5, and 350-1. Replace any faulty tubes. *b*. Check the —150, +300, and +500 power supply voltages. See paragraphs 68b(1), 68b(3), and 68c(2) of this section. *c*. Refer to schematic diagram of the indicator unit (fig. 59); Connect the Class A oscilloscope as a test scope by inserting a test lead into + PULSE jack on the left-hand side of the indicator unit panel; and check waveforms throughout the PPI oscilloscope sweep circuit. Compare these waveforms with those given in figures 112 and 113 to locate the faulty stage. *d*. Take voltage and resistance measurements of the suspected stage and compare with those given in figure 117 to locate the faulty circuit component.

PROBABLE LOCATION OF FAULT	PROCEDURE
3. PPI oscilloscope sweep-circuit (contd).	*e.* Check range switch 393-2 for loose or shorted connection. Replace switch if faulty. *f.* Replace PPI oscilloscope tube. See paragraph 71a. *g.* Replace PPI oscilloscope deflecting coil assembly. See paragraph 71d.
4. PPI oscilloscope video circuit.	4*a.* Check tubes 351-1 and 351-2. Replace if faulty. *b.* Press the RANGE MARKER button. If markers appear on the PPI oscilloscope, the trouble is probably in tube 351-1. If markers do not appear, the trouble is probably in tube 351-2. *c.* Make voltage and resistance checks of the suspected stage and compare with those in figure 117 to locate the fault within the stage. *d.* Check for loose or shorted connections from the video output (pin No. 8 of 351-2) to the grid of the PPI oscilloscope (pin No. 5 of 347).

E. SYMPTOMS:

1. No sweep line or grass on Class A oscilloscope, or abnormal appearance of sweep line or grass.
2. PPI sweep line and ground echoes appear normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Improper adjustment of CLASS A BRIGHTNESS control.	1. Turn up CLASS A BRIGHTNESS control.
2. Class A oscilloscope circuit.	2*a.* Adjust CLASS A FOCUS, HOR CENT, and VERT CENT to try to obtain proper scope picture. *b.* With a test oscilloscope check for a sawtooth waveform at pin No. 10 or No. 11 of Class A oscilloscope tube socket. If present, proceed to next step. *c.* Check the —1,200, —150, +150, +500, and +300 power supply voltages. See paragraphs 68b (1), 68b (3), and 68c (2) of this section. *d.* Take voltage and resistance measurements at the socket of the Class A oscilloscope tube and refer to figures 57, 59, and 119 to locate the faulty circuit component.
3. Class A oscilloscope sweep circuit.	3*a.* Check tubes 352-3, 351-8, and 352-6. Replace any faulty tubes. *b.* Check the —150 and +300 power supply voltages. See paragraphs 68b (1), 68b (3), and 68c (2) of this section. *c.* Refer to schematic diagram of the indicator unit (fig. 59), and with the test oscilloscope check waveforms throughout the Class A oscilloscope sweep circuit. Compare with those given in figures 114 and 115 to locate the faulty stage.

PROBABLE LOCATION OF FAULT	PROCEDURE
3. Class A oscilloscope sweep-circuit (contd).	*d.* Take voltage and resistance measurements of the suspected stage and compare with those given in figure 117 to locate the faulty circuit component. *e.* Check range switch 393-1 for loose or shorted connection. Replace switch if faulty. *f.* Replace the Class A oscilloscope tube. See paragraph 71f.
4. Class A oscilloscope video circuit.	4*a.* Check tubes 351-5 and 351-6. Replace if faulty. *b.* Press the RANGE MARKER button. If markers appear on the Class A oscilloscope, the trouble is probably in tube 351-5. If markers do not appear, the trouble is probably in tube 351-6. *c.* Make voltage and resistance checks of the suspected stage and compare with those in figure 117 to locate the fault within the stage. *d.* Check for loose or shorted connections from the video output (pin No. 8 of 351-6) to the vertical deflecting plate of the Class A oscilloscope (pin No. 7 of 346).

F. SYMPTOM:

Range marker circles do not appear on the PPI oscilloscope, or do not appear normal, when the RANGE MARKER button is pressed.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Video amplifier tube 351-2.	1. Check waveform on pin No. 4 of this tube. If marker pips are present, the fault is in this video amplifier stage. If the markers appear but there are damped oscillations on the trailing edge of the pips, check that the video input leads do not run close to the output (pin No. 8) of tube 351-2. If markers are not present, proceed to the next step.
2. Range marker circuit.	2*a.* Check tubes 352-1, 351-3, and 351-4. Replace any faulty tubes. *b.* Refer to schematic diagram of the indicator unit (fig. 59); connect the Class A oscilloscope as a test scope by inserting a test lead into + PULSE jack on the left-hand side of the indicator unit panel; and check waveforms throughout the range marker circuit. Be sure to check at terminal M4 on the terminal strip on the marker chassis to see that the negative trigger pulse is being applied to tube 352-1. Compare the waveforms obtained with those in figures 110 and 111 to locate the faulty stage. *c.* Take voltage and resistance measurements of the suspected stage and compare with those in figure 118 to locate the faulty circuit component. *d.* Check for proper adjustment of capacitor 341. The procedure for calibrating the range marker circuit and adjusting capacitor 341 is given in paragraph 72c(3) (*f*) or 72c(3) (*g*) of this section.

G. SYMPTOM:

Range marker pips do not appear on the Class A oscilloscope, or do not appear normal, when RANGE MARKER button is pressed.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Video amplifier tube 351-6.	1. Check waveform at pin No. 4 of this tube. If markers are present, the fault is in this video amplifier stage. If the markers appear but there are damped oscillations on the trailing edge of the pips, then check that the video input leads do not run close to the output (pin No. 8) of tube 351-6. If markers are not present, proceed to the next step.
2. Range marker circuit.	2. Refer to fault No. 2, symptom F above, for procedure in locating trouble in the range marker circuit.

H. SYMPTOM:

Pip amplitude on the Class A oscilloscope does not change when GAIN control is varied.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. GAIN control circuit.	1*a*. Check for faulty GAIN control knob or potentiometer. *b*. Check for broken or disconnected leads or shorts in the GAIN control circuit.

I. SYMPTOM:

Impossible to obtain proper number of range markers on the PPI oscilloscope by varying the ADJ RANGE and SWEEP LENGTH controls.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. PPI oscilloscope sweep circuit.	1*a*. Check that potentiometers 294-1 and 285 have proper resistance values. *b*. Refer to fault No. 3, symptom D above, for procedure in locating trouble in the PPI oscilloscope sweep circuit.
2. Range marker circuit.	2. Refer to fault No. 2, symptom F above, for procedure in locating trouble in the range marker circuit.

J. SYMPTOM:

Impossible to obtain proper number of range markers on the Class A oscilloscope by varying the RANGE and SWEEP LENGTH controls.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Class A oscilloscope sweep circuit.	1*a*. Check that potentiometers 294-2 and 295 have proper resistance values. *b*. Refer to fault No. 3, symptom E above, for procedure in locating trouble in the Class A oscilloscope sweep circuit.
2. Range marker circuit.	2. Refer to fault No. 2, symptom F above, for procedure in locating trouble in the range marker circuit.

K. SYMPTOM:

PPI dial lamps do not light when POWER switch is thrown to ON, but sweep lines on both oscilloscopes appear normal.

PROBABLE LOCATION OF FAULT	PROCEDURE
1. Dial lamps circuit.	1*a*. Adjust SCREEN LIGHT control to see if this causes lamps to light. *b*. Check for burned-out lamps; replace if faulty. *c*. Check resistor 301 for proper value and tight connections. *d*. Check for loose or broken connections in dial lights circuit.

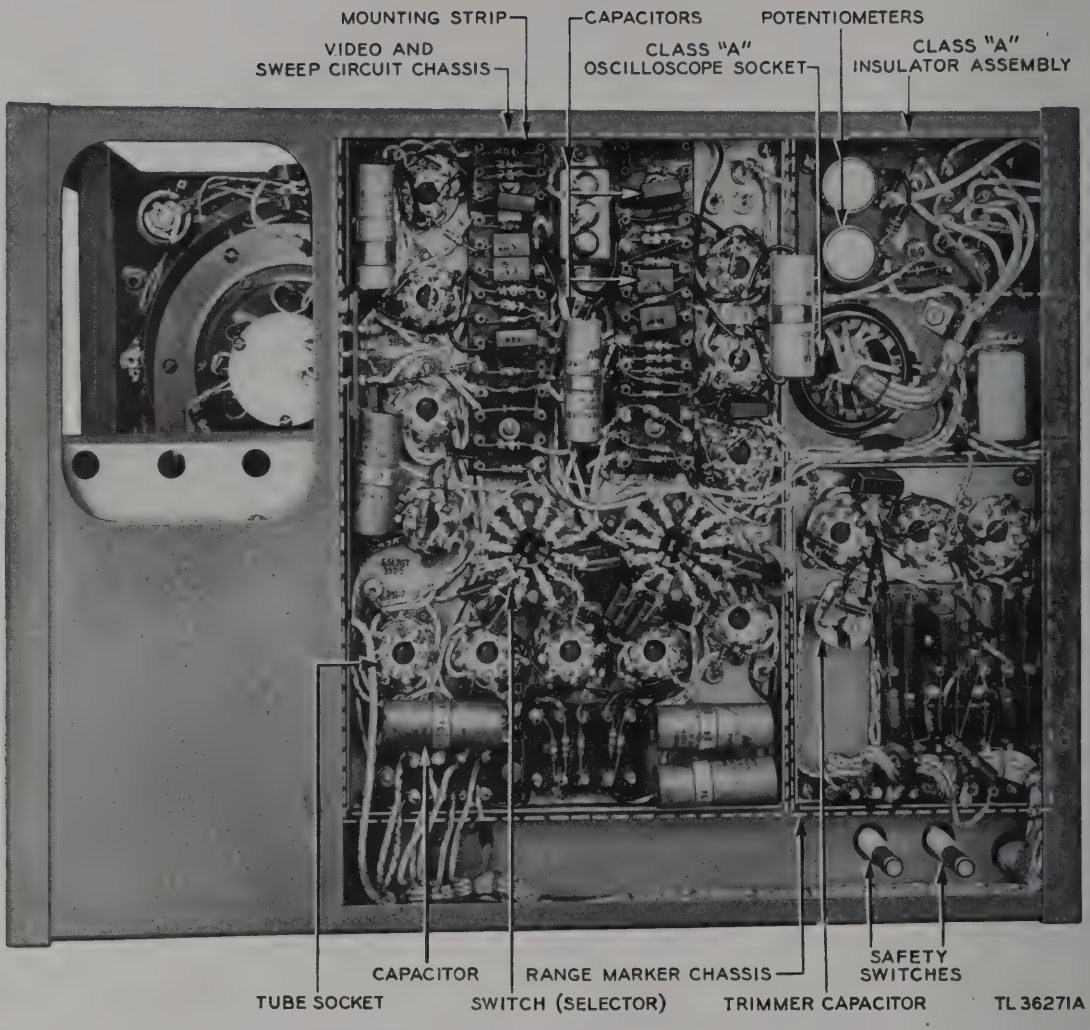


Figure 104. Indicator Unit ID-16/TPS-1A, rear view of chassis.

70. ADJUSTMENTS.

a. Adjustment of Trimmer Capacitor 341. Capacitor 341 is the timing adjustment for the range markers circuit. It is mounted on a small chassis at the rear of the indicator unit (fig. 104). The capacitor control appears on the front side of the small chassis, and is not accessible unless the indicator unit is removed from the tower section. Do not adjust this capacitor unless absolutely necessary and unless definite information exists that shows there is an error in the range marker circuit which causes the marker pips to represent a distance other than 10-mile intervals. The procedure for calibrating the range marker circuit is given in paragraph 72c(3)(*f*) or 72c(3)(*g*) of this section.

b. Adjustment of Contact Spring Pressure on Slip Rings of Deflecting Coil of PPI Oscilloscope (fig. 105). (1) Remove the PPI oscilloscope tube as described in paragraph 71a.

(2) The contact springs are exposed through the two holes in the centering ring assembly.

(3) To adjust the contact spring pressure, engage the No. 363 adjustment tool, stored in Tool Kit TK-9/TPS-1, over the spring at a point near its supported end or close to a point grasped by long-nose pliers.

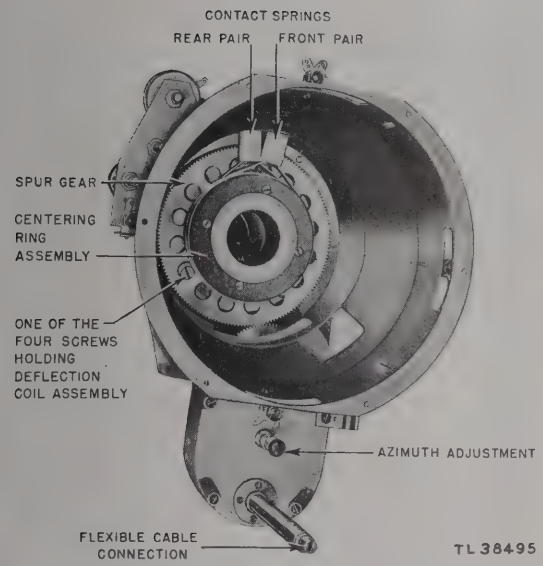


Figure 105. Deflection coil, slip rings, gears, and contact springs.

(4) Gently twist the adjusting tool clockwise on the right-hand springs to increase, and counterclockwise to decrease the contact force; on the left-hand springs counterclockwise to increase, and clockwise to decrease the contact force. Great care must be taken not to cause kinks in the contact spring.

(5) Open the No. 68C gram gauge as the blade of a jack knife is opened.

(6) Holding the gauge steady, catch the tip of the reed under the contact spring near the contact while holding the reed at right angles to the contact spring and parallel to the spring's width.

(7) Gently lift the contact away from the slip ring and take a reading when contact just separates from the slip ring. The force of the contact springs against the deflecting coil slip rings should be between 20 and 36 grams.

(8) Check this force at three points 120 degrees apart on the slip rings. To test at the

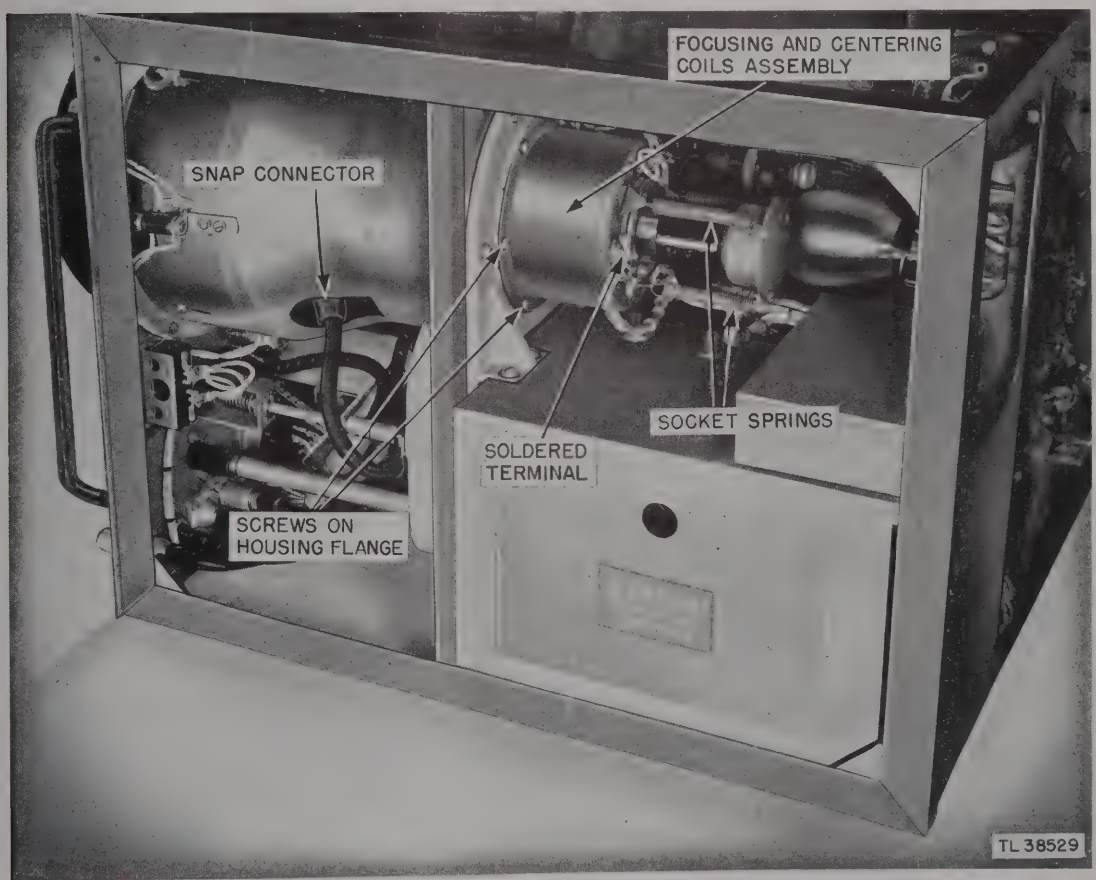


Figure 106. Indicator Unit ID-16/TPS-1A, right side showing parts involved in replacement of focusing and centering coil assembly.

three points, hand-rotate the deflecting coil by turning the long flexible drive shaft, or, if the coil housing is in the indicator unit, lift the lock bar and press and rotate the AZIMUTH control knob to rotate the coil. See TM 11-1347A for azimuth adjustment.

71. REPLACEMENT OF PARTS.

a. Replacement of PPI Oscilloscope Tube (larger tube at right front, figure 44).

(1) Pull off the snap connector at the bottom right side of the tube (fig. 106).

(2) Loosen the three bezel clamping screws and remove the bezel (fig. 107).

(3) Remove the azimuth dial and marking dial from the locating pins on retaining ring.

(4) Remove the three screws which fasten the retaining ring to the tube shield, and move the tube outwards to release socket spring tension.

(5) Pull off the socket.

(6) Remove the tube.

CAUTION: A dangerous explosion of flying glass particles results when an oscilloscope tube breaks. Handle the tube carefully, since even a slight jarring may cause the tube to shatter. Wear gloves and goggles to protect the hands and eyes in case the tube explodes.

(7) To replace the PPI oscilloscope tube, place the tube in position through the hole in the front panel, carefully guiding the stem through the opening in the deflecting coil assembly.

(8) Push the socket onto the tube base, and align the contact on the side of the tube with the opening through the tube shield.

(9) Place the retaining ring in position and *start* the three screws.

(10) Press the retaining ring firmly against the tube and *tighten* the screws.

(11) Place the marking dial and then the azimuth dial with the zero-degree mark at the top on the locating pins of the retaining ring.

(12) Slip the bezel into position, pressing firmly against the azimuth dial, and clamp in place with the bezel clamping screws.

(13) Replace the connector at the bottom right side of the tube just back of the bulge.

b. Replacement of Azimuth Dial Screen Lights (fig. 103). (1) The dial lamps are mounted in bayonet sockets. The top and right-side lamps can be reached with the fingers. The bottom and left-side lamps are accessible only after removal of the PPI tube.

(2) To replace the top or right-side lamp, simply remove the faulty lamp from its bayonet socket and insert the new lamp.

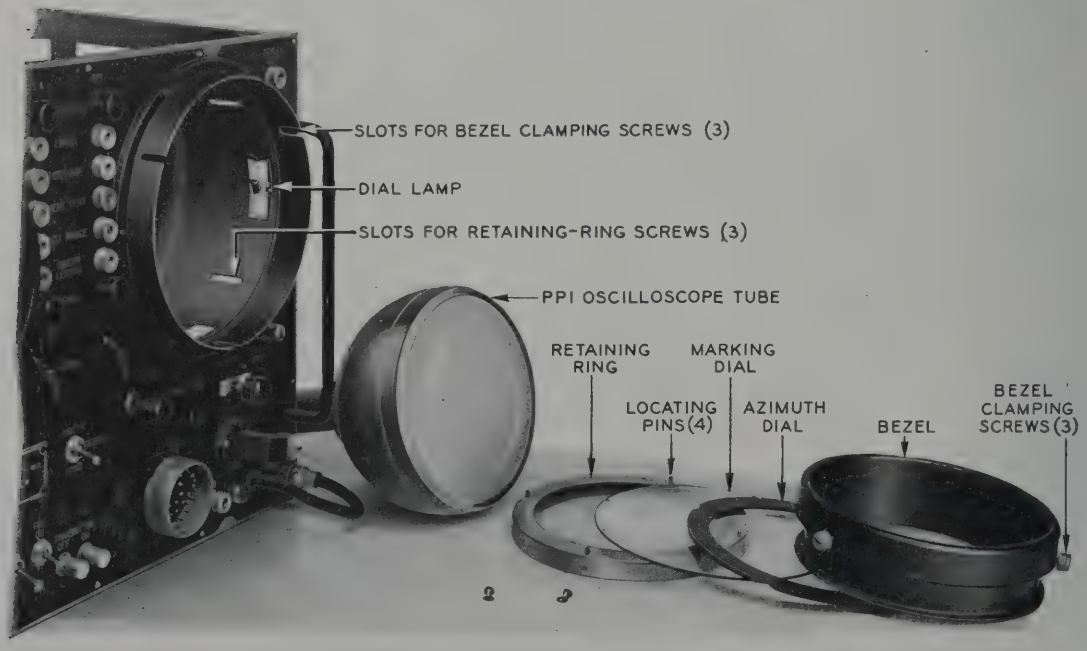


Figure 107. Indicator Unit ID-16/TPS-1A, PPI oscilloscope tube removed.

(3) To replace the bottom or left-side lamp, first remove the PPI tube as outlined in subparagraph a above; then remove the faulty lamp from its bayonet and insert the new lamp.

c. Replacement of PPI Oscilloscope Focusing and Centering Coils Assembly (fig. 106).
(1) Remove the PPI oscilloscope tube as described in subparagraph a above.
(2) Unhook the three socket springs from the focus coil housing (fig. 106).
(3) Mark the six leads on the coil terminals 1 to 6 on the housing and unsolder them from the terminals.
(4) Remove the six screws on the housing flange with their lockwashers (fig. 106).
(5) The housing with coils is now free and can be removed.
(6) To replace the PPI oscilloscope focusing and centering coils, insert and tighten the six screws on the housing flange.
(7) Solder the six leads to their proper terminals on the housing.
(8) Hook into place the three socket springs.
(9) Replace the PPI oscilloscope tube as described in subparagraph a above.

d. Replacement of PPI Oscilloscope Deflecting Coil Assembly (fig. 105). (1) Remove the PPI oscilloscope tube (subpar. a above).
(2) Remove the contact spring holder assembly (fig. 103) on top of the tube housing by removing the four screws attaching it to the housing.
(3) Remove the centering ring assembly (fig. 105) by removing the four screws (fig. 105) and pulling out through the aperture in the front panel.
(4) Turn the large spur gear with the holes in it by means of the AZIMUTH control to a position which exposes the heads of the four screws (fig. 105) holding the deflecting coil assembly. These screws are staked but can be removed.
(5) The deflecting coil assembly is now free and can be removed.
(6) To replace the deflecting coil assembly, insert and tighten the four screws holding it in place.
(7) Insert the centering ring assembly through the front panel aperture. Replace it into its proper position. Insert and tighten the four screws to hold it.
(8) Replace the contact spring holder assembly. Insert and tighten the four screws to hold it.
(9) Replace the PPI oscilloscope tube as described in subparagraph a above.

e. Replacement of PPI Drive Gears and Mechanism (fig. 108). (1) Remove the right-angle flexible shaft connection on the front of the indicator unit by removing the four screws attaching it to the front panel.
(2) Remove the four screws connecting the drive shaft to the gearbox assembly and slide the drive shaft forward until free, then to the rear and to the right until removed.
(3) Loosen the setscrew holding the rear small clutch face of the AZIMUTH knob shaft and remove the clutch face from the shaft.
(4) Remove the cotter key from the shaft and the spring and washer assembly from the shaft.
(5) Remove the four screws holding the front cover plate of the gearbox.
(6) The gears are now accessible and can be removed from the gearbox.
(7) To replace, reverse the above procedure. Be sure to put on the oilite washer first when replacing the spring and washer assembly on the shaft.

f. Replacement of the Class A Oscilloscope Tube (smaller tube at left front, fig. 44).
(1) Pull off the snap connector at the left side of the tube behind the large bulge (fig. 58).
(2) Pull off the socket (fig. 104). Using a screwdriver, carefully pry it loose by manipulation through the slot in the tube shield at the base.
(3) Remove the four screws which mount the bezel on the face of the front panel. Remove the bezel and filter.
(4) With a screwdriver loosen the clamp at the base of the Class A oscilloscope (fig. 58).
(5) Remove the tube through the hole in the front panel.

> **CAUTION:** A dangerous explosion of flying glass particles results when an oscilloscope tube breaks. Handle the tube carefully, since even a slight jarring may cause the tube to shatter. Wear gloves and goggles to protect the hands and eyes in case the tube explodes.

(6) To replace the Class A oscilloscope tube,

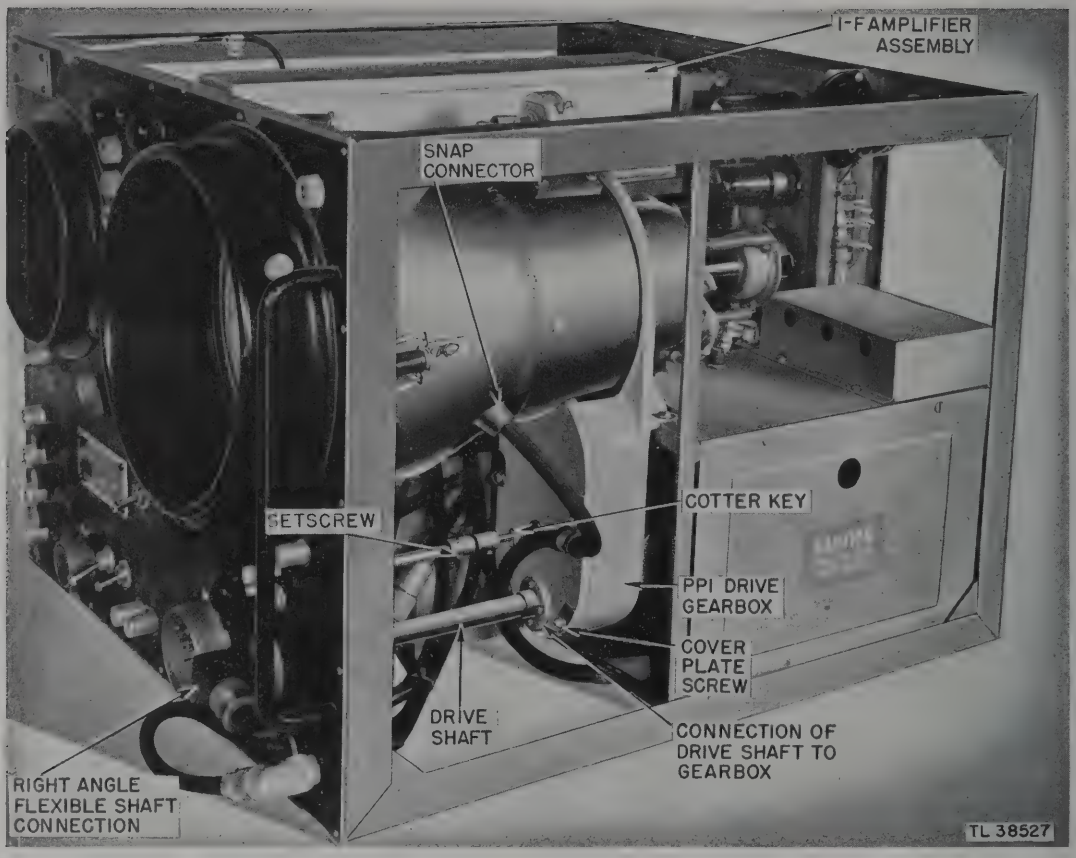


Figure 108. Indicator Unit ID-16/TPS-1A, right side showing parts involved in replacement of PPI drive gears and mechanism.

place the tube in position through the hole in the front panel.

(7) Push the socket onto the tube base, rotating the tube to match the base key to the socket slot, and align the contact on the side of the tube with the hole in the shield.

(8) Mount the bezel on the front panel.

(9) Press the tube against the bezel and tighten the clamp at the tube base.

(10) Snap on the side connector.

72. TESTING OF COMPONENTS.

a. General Information. The following tests can be used to check the individual components of the indicator system. Apparatus designations in general are stamped on or near the part under discussion. Also check against the appropriate schematic diagram or wiring diagram.

b. Test Equipment. (1) The following equipment and facilities are required to perform the tests described below. Information on special test equipment can be obtained from the handbooks describing such equipment.

(*a*) Power supply: 400 cycles, 115 volts, 1,250 watts; and 27 volts direct current, 300 watts.

(*b*) Test Unit TS-104/TPM-1.

(*c*) Line Monitor TS-106/TPM-1.

(*d*) Set of connecting cords X-61718K.

(*e*) Test Oscilloscope TS-34/AP.

(*f*) Electrodynamometer: 400 cycles, range to 150 volts.

(*g*) Test Set TS-96/TPS-1 (precision multirange tester, 856P).

(2) In addition to the above items of test equipment, a set of connecting cables for Radio Set AN/TPS-1A should be available.

c. Tests on Indicator Unit ID-16/TPS-1A.

(1) TESTS DESCRIBED.

(*a*) Regulated rectifier.

(*b*) High-voltage rectifier.

(*c*) Cathode-ray oscilloscope tube circuit.

(*d*) Sweep circuits.

(*e*) Range marker circuit.

CAUTION: *IN MAKING THESE TESTS IT IS NECESSARY IN MOST CASES TO REMOVE THE INDICATOR UNIT CHASSIS FROM ITS SHIELD IN TOWER SECTION NO. 2. THIS EXPOSES HIGH-VOLTAGE CIRCUITS, CONTACT WITH WHICH MAY BE DANGEROUS TO LIFE. EXERCISE EXTREME CAUTION WHEN WORKING ON THE UNITS.*

(2) PREPARATIONS FOR TESTING.

(*a*) When the indicator unit chassis is removed from its shield, it is necessary to block closed switch 392-1 at the rear of the unit.

(*b*) For all tests, supply power to the indicator unit as follows:

1. Connect one end of blue-coded Cord CX-69/TPS-1, or equivalent, to the power source.
2. Connect the 1-foot, blue-coded adapter cord to the other end of Cord CX-69/TPS-1.
3. Connect the adapter cord to input connector on Line Monitor TS-106/TPM-1.
4. Connect the yellow end of the 6-foot cord to the output connector of the monitor, and the blue end to the GENERATOR connector on the indicator unit panel.

(*c*) The line monitor provides means for adjusting the voltage to the indicator unit, as measured at test points on the monitor panel. Adjust and maintain the voltage at 115 volts unless otherwise indicated.

(*d*) When d-c and a-c voltages are supplied to the set through the line monitor, d-c power for the indicator unit is controlled by the POWER switch on the indicator unit panel; a-c power is controlled by a switch on the line monitor and the POWER switch on the indicator unit panel.

(3) TESTS.

(*a*) *Test of Regulated Rectifier.*

1. The tubes and all subchassis must be in place. Throw the POWER switch on the indicator unit to ON.
2. Check that the filaments light in rectifier circuit tubes 348-1, 348-2, 350-2, 350-3, 350-4, 352-7, and 349.
3. If they do not light, see if fuse B is good. If fuse B has blown, check that the 300-volt, 500-volt, or —150-volt supply lines are not grounded. Check the 300-volt line at the 300-volt test point (fig. 103), the 500-volt line at terminal V6, and the —150-volt line at terminal V7.
4. If the tubes are lighted, check that 300 volts is present at test point 396-2. If this voltage is not present, adjust to 300 volts with potentiometer 291-1 (fig. 103). The range of control of potentiometer 291-1 should be at least such as to permit the voltage to be set to a value between 290 volts and 310 volts.
5. If the voltage cannot be adjusted to 300 volts, determine whether any of the rectifier tubes are defective. Replace all defective tubes and recheck the voltage.

(*b*) *Test of High-voltage Rectifier.*

CAUTION: *EXTREME CAUTION MUST BE EXERCISED WHEN CHECKING THE HIGH-VOLTAGE RECTIFIER TO AVOID CONTACT WITH THE HIGH-VOLTAGE CIRCUITS. DO NOT CONNECT OR DISCONNECT METERS WHEN POWER IS ON. DO NOT TOUCH METERS OR LEADS CONNECTED TO HIGH-VOLTAGE CIRCUITS WHEN POWER IS ON.*

1. The tubes and all subchassis must be in place.
2. Throw the POWER switch on the indicator unit to ON.
3. See if the filament of rectifier tube 345 is lighted.
4. If it is not lighted, and the sweep chassis tubes and the screen lights on the PPI oscilloscope screen are also out, check fuse A.
5. If tube 345 lights, throw the POWER switch to the off position. Set the voltmeter of Test Set TS-96/TPS-1 to the 6,000-volt scale, connect the positive test lead to terminal 4 of high-voltage transformer 359 or 360 (par. 24c), and

connect the negative test lead to ground (chassis frame).

6. Throw the POWER switch to ON.
7. The meter should read between 4,500 and 5,500 volts.
8. If it does not, throw the POWER switch to the off position. Check resistance 279 plus 280. This should be about 7 megohms. Check the resistance from terminal 5 of transformer 359 or 360 (par. 24c) to ground; this resistance should be about 1.6 megohms.

(*c*) *Test of Oscilloscope Tube Circuits.*

1. Throw the POWER switch to ON.
2. See if a spot appears at the center of PPI tube 347, and if it is possible to focus and change intensity by adjustment of the FOCUS and BRIGHTNESS controls.
3. If no spot appears and the tube is not defective, throw the POWER switch to the off position. Check that the connector on the high-voltage lead to the side of tube 347 is fastened securely in place. If this connection is good, check the high-voltage rectifier.
4. If a spot appears, but changes in intensity and focus independently of the controls, check the circuit for poor connections from terminal 4 of transformer 359 or 360 (par. 24c) to the tube.
5. If a spot appears, but cannot be focused, check that 300 volts is applied to pin 3 of tube 347 and to terminal 2 of focus coil 708. The voltage drop across terminals 1 and 2 of focus coil 708 should be from 150 to 250 volts.
6. If a spot flares up, and continues to bloom independently of the BRIGHTNESS potentiometer, check that the voltage is negative on terminal 5 of the PPI tube 347.
7. Observe whether a spot appears on Class A oscilloscope tube 346 when the BRIGHTNESS and FOCUS controls are adjusted. It may be necessary to turn the HOR CENT control to the extreme clockwise position when checking the above to bring the spot toward the center of the screen.
8. If a spot does not appear, but one is present on the PPI oscilloscope, check that the filament of Class A oscilloscope 346 is lighted. If it is not, and the sweep chassis tubes also are not lighted, check fuse A.
9. If Class A oscilloscope tube 346 is lighted, if the tube is not otherwise defective, and if the high-voltage rectifier is functioning, but a spot does not appear, check the resistors in the voltage supply potentiometer. These are resistors 270-1, 270-2, and 234, and potentiometers 290 and 293.
10. If the spot cannot be focused, check the above resistors. See if 300 volts is applied to pin 9 of Class A oscilloscope tube 346.

(*d*) *Tests of Sweep Circuits.*

1. Connect the C RF UNIT connector on the indicator unit panel to the INDICATOR connector of Test Unit TS-104/TPM-1 with the 3-foot, orange-coded cord.
2. Throw the POWER switch on the indicator unit panel to ON. Turn on the triggering circuit of Test Unit TS-104/TPM-1.
3. After a warm-up period, and after adjustment of the BRIGHTNESS and FOCUS controls, sweep lines should appear on PPI and Class A oscilloscopes.
4. If the tests of subparagraph (c) above have been made, and if spots but no sweep lines appear, make the following checks.
5. If no sweep lines appear on either PPI or Class A oscilloscopes, determine with Test Oscilloscope TS-34/AP that a short-duration triggering pulse appears on terminal V8. This pulse should have an amplitude of at least 20 volts as measured on the test oscilloscope.
6. If the Class A oscilloscope has a sweep and there is no sweep on the PPI oscilloscope, check that waveforms similar to those in figure 51 are present at corresponding points throughout the sweep circuit.
7. If the Class A oscilloscope has no sweep, but the PPI oscilloscope has a sweep, check that waveforms similar to those shown in figure 51 are present at designated points.
8. If these waveforms are not present, check that plate voltages are being supplied. Check for defective tubes or resistances.

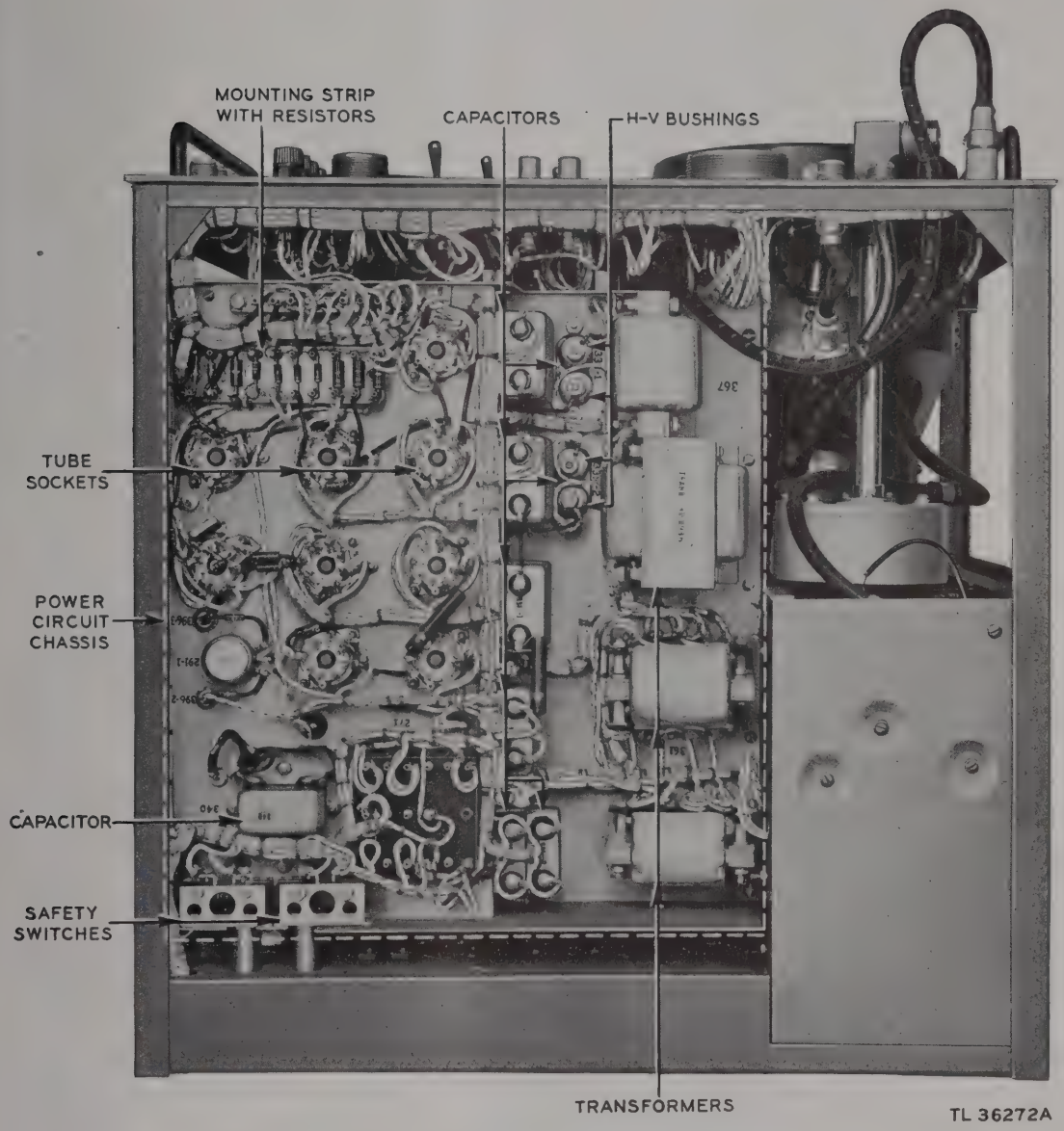


Figure 109. Indicator Unit ID-16/TPS-1A, bottom view of chassis.

(*e*) *Tests of Video Amplifier.*

1. The test set-up is the same as that for the sweep circuits (subpar. (*d*) above).
2. Throw the POWER switches on the indicator unit and the test unit to ON.
3. With the i-f amplifier operating normally, and the range marker circuit functioning properly, press the RANGE MARKER button. Observe that the height and shape of the marker pips are normal on the Class A oscilloscope.
4. This is an operating test of the video amplifier. If the markers do not appear on the Class A or PPI oscilloscopes, trouble may be found either in tubes 322-3 or 322-4, or in their associated circuits.
5. In order to check the first stage of the video amplifiers, it is necessary to apply a signal to the video input. A signal for this purpose may be obtained from Range Calibrator TS-5/AP. Make con-

nections as described in the instructions for Test Unit TS-104/TPM-1. Regularly spaced pips, similar to the range marker pips, should appear on the oscilloscope tubes. The amplitude of these pips on the Class A oscilloscope should be variable by means of the CLASS A GAIN potentiometer. The brightness of the pips on the PPI oscilloscope should be variable by means of the PPI GAIN potentiometer. If the pips do not appear on the Class A oscilloscope, trouble may be found in tube 351-5 or its associated circuit. If the bright spots do not appear on the PPI oscilloscope, trouble may be located in tube 351-1 or its associated circuit.

(f) *Field Check of Range Markers.*

1. Find a suitable permanent echo. Identify on a chart the landmark causing the echo. Determine the distance on the chart between the landmark and the site of the radio set. Point the antenna toward the permanent echo. An echo at a definite distance can be obtained by causing an airplane to fly over a charted and identifiable landmark and having the pilot report his position.
2. Press the RANGE MARKER button of either the Class A or PPI oscilloscope and, using the distance to the permanent echo as a reference, check against the range as determined with the range markers.
3. To adjust the range markers in the field is a cut-and-try procedure:
   (a) Throw the POWER switch on the indicator unit to the off position.
   (b) Unclamp and pull out the indicator unit.
   (c) Adjust trimmer capacitor 341 (fig. 104).
   (d) After the adjustment, slide the incator unit back into position, throw the POWER switch to ON. Wait 3 minutes, then press the TRANSMITTER ON button.
   (e) Recheck the range markers.

(g) *Calibration of Range Marker Circuit.*

1. Connect the INDICATOR connector of Test Unit TS-104/TPM-1 to the C RF UNIT connector of the indicator unit, with the 3-foot, orange-coded cord.
2. Make the connections necessary for range calibration as described in the instructions for Test Unit TS-104/TPM-1.
3. Connect one of the cords furnished with Range Calibrator TS-5/AP to the calibrator output jack. Connect the other end to the VIDEO INPUT jack on the indicator unit panel.
4. Set the range switch on the calibrator to 10 statute miles.
5. Throw the POWER switches on the indicator unit, test unit, and calibrator to the ON positions. Allow about 10 minutes or more for warm-up.
6. The calibrator markers appear on the sweep lines of the Class A and PPI oscilloscopes. Adjust the BRIGHTNESS and FOCUS controls of the Class A oscilloscope for best definition. Set the range to 100 miles with the RANGE control switch.
7. Press the CLASS A RANGE MARKER button on the indicator unit panel. If the marker pips fall at varying distances from the corresponding calibrator pips, adjust variable capacitor 341 on the sweep chassis of the indicator unit to equalize the distances over the full range. The range marker circuit is now calibrated to indicate 10-statute-mile intervals on the Class A and PPI oscilloscope sweep lines.
8. If no marker pips appear on the Class A oscilloscope when the RANGE MARKER button is pressed, check that they are present at grid 1 of marker generator tube 352-1, using Test Oscilloscope TS-34/AP. If pips do not appear at grid 1 of tube 352-1, this tube or the associated circuit is probably defective.
9. If pips appear but do not synchronize with the sweep, the synchronizing pulse applied to the marker circuit may be of too low voltage.

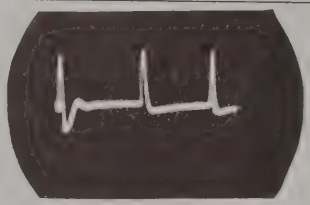
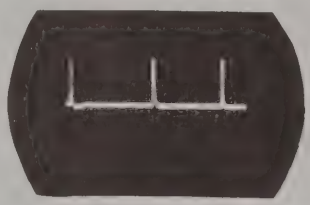
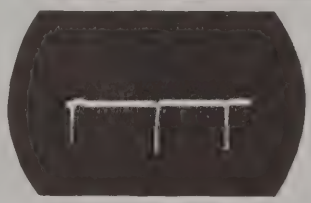
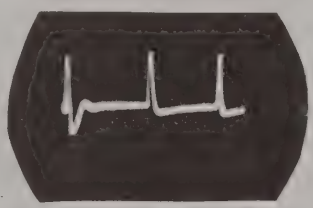
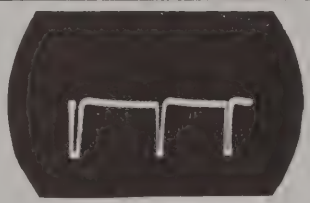
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORM OF VOLTAGE TO GROUND
ELECTRONIC MARKER TUBE 352-1	1. WITHDRAW INDICATOR UNIT ID-16/TPS-1A FROM CASE. 2. CONNECT ALL CABLES ON SET EXCEPT VIDEO INPUT TO INDICATOR UNIT. 3. BLOCK THE TWO INTERLOCK SWITCHES CLOSED. ON REAR OF UNIT.	PIN 5 PLATE 1	
		PIN 2 PLATE 2	
		PIN 4 CONTROL GRID 1	
PPI MARKER AMPLIFIER TUBE 351-3	PPI RANGE MARKER SWITCH DEPRESSED	PIN 4 GRID	
		PIN 8 PLATE	

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Figure 110. Indicator Unit ID-16/TPS-1A, test waveforms for tubes 352-1 and 351-3.

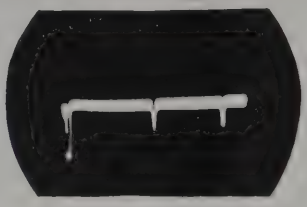
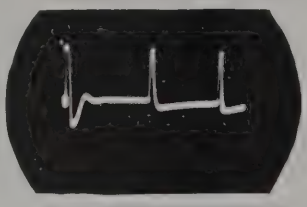
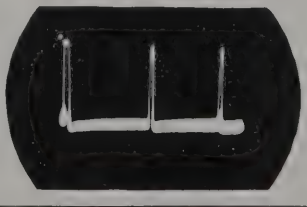
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORM OF VOLTAGE TO GROUND
PPI VIDEO AMPLIFIER 2 TUBE 351-2	PPI RANGE MARKER SWITCH DEPRESSED	PIN 4 CONTROL GRID	
		PIN 8 PLATE	
CLASS A RANGE MARKER AMPLIFIER TUBE 351-4	CLASS A RANGE MARKER SWITCH DEPRESSED	PIN 4 CONTROL GRID	
		PIN 8 PLATE	
CLASS A VIDEO AMPLIFIER 2 TUBE 351-6	CLASS A RANGE MARKER SWITCH DEPRESSED	PIN 4 CONTROL GRID	
		PIN 8 PLATE	

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Figure 111. Indicator Unit ID-16/TPS-1A, test waveforms for tubes 351-2, 351-4 and 351-6.

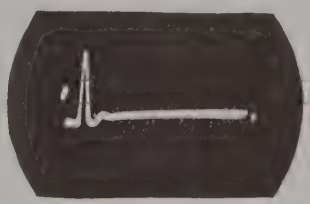
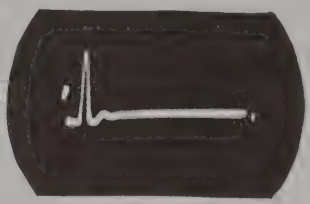
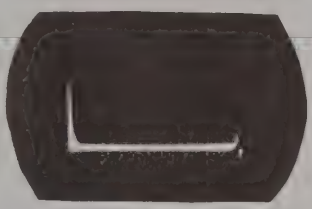
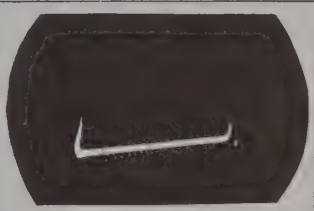
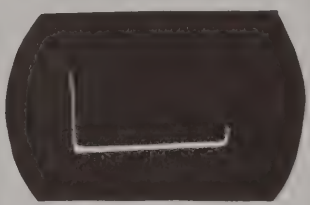
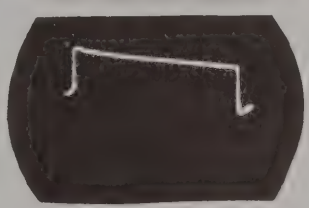
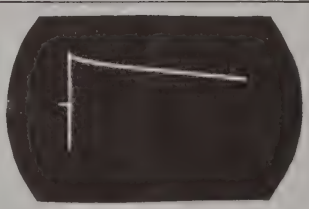
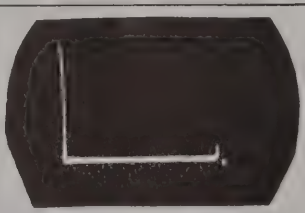
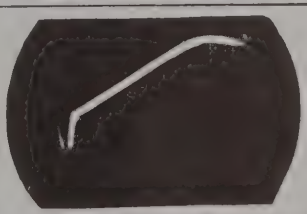
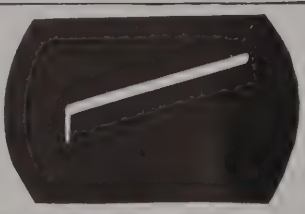
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORM OF VOLTAGE TO GROUND	
			20 MILE RANGE	60 MILE RANGE
PPI PRE-PULSER TUBE 352-2		PIN 4 CONTROL GRID 1		
		PIN 5 PLATE 1		
		PIN 1 CONTROL GRID 2		
		PIN 2 PLATE 2		
PPI SWEEP GENERATOR TUBE 351-7	PPI RANGE SWITCH IN EITHER 20 OR 60 MILE POSITION	PIN 4 CONTROL GRID		
		PIN 8 PLATE		

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Figure 112. Indicator Unit ID-16/TPS-1A, test waveforms for tubes 352-2 and 351-7.

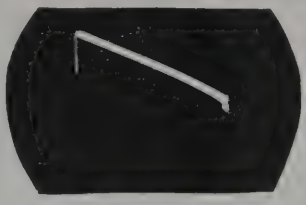
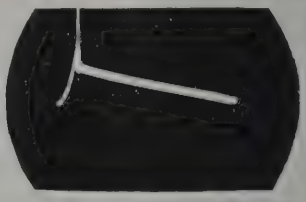
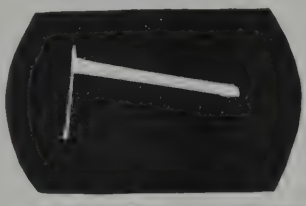
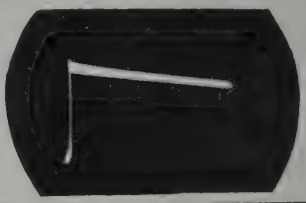
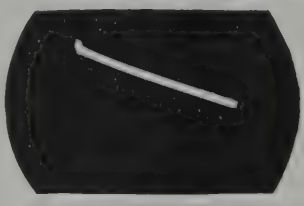
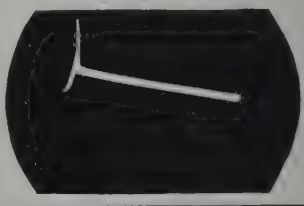
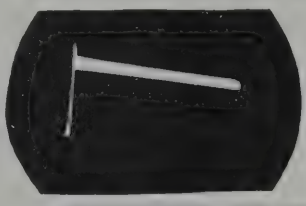
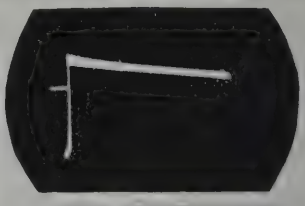
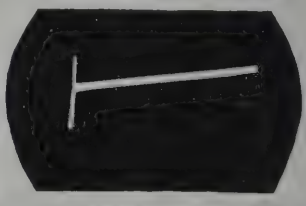
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORMS OF VOLTAGE TO GROUND	
			20 MILE RANGE	60 MILE RANGE
PPI SWEEP AMPLIFIER TUBE 352-5	1-PPI RANGE SWITCH IN EITHER 20 OR 60 MILE POSITION	PIN 5 PLATE 1		
	2-PPI SWEEP LENGTH AT NORMAL SETTING.	PIN 2 PLATE 2		
		PIN 1 CONTROL GRID 2		
PPI SWEEP AMPLIFIER TUBE 350-1		PIN 5 CONTROL GRID		
		PIN 3 PLATE		
		PIN 8 CATHODE		

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Figure 113. Indicator Unit ID-16/TPS-1A, test waveforms for tubes 352-5 and 350-1.

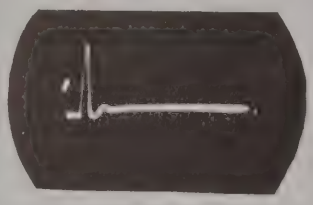
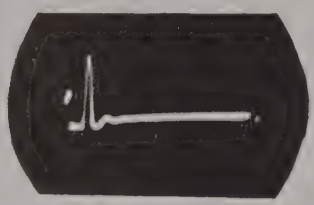
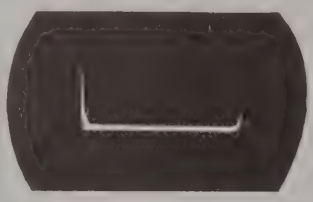
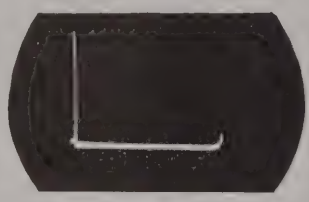
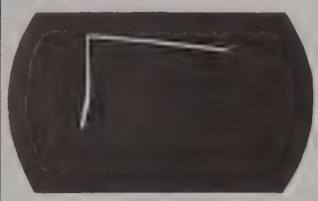
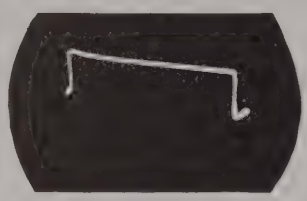
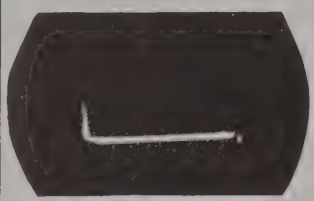
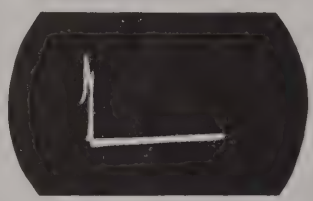
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORMS OF VOLTAGE TO GROUND	
			20 MILE RANGE	100 MILE RANGE
CLASS A PRE-PULSER TUBE 352-3	CLASS A RANGE SWITCH IN EITHER 20 OR 100 MILE POSITION	PIN 4 CONTROL GRID 1		
		PIN 5 PLATE 1		
		PIN 2 PLATE 2		
		PIN 1 CONTROL GRID 2		

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Figure 114. Indicator Unit ID-16/TPS-1A, test waveforms for tube 352-3.

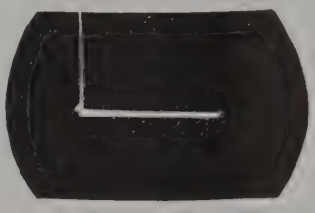
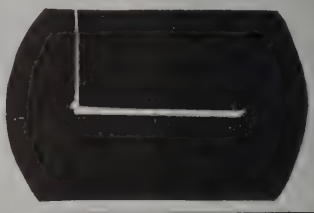
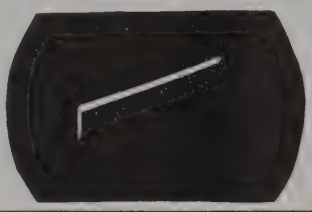
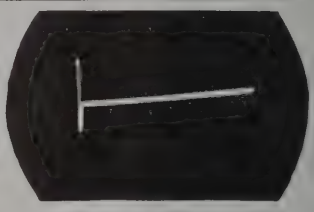
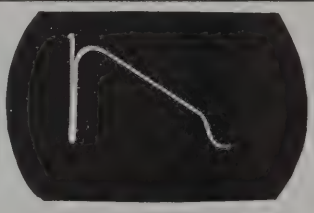
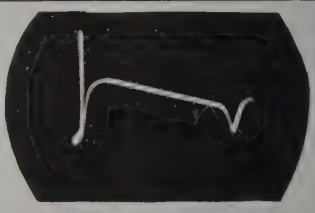
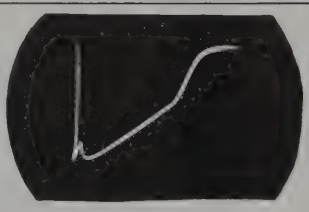
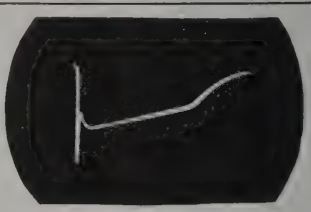
CIRCUITS TO BE TESTED	CONDITIONS REQUIRED	TEST POINT	NORMAL WAVEFORM OF VOLTAGE TO GROUND	
			20 MILE RANGE	100 MILE RANGE
CLASS A SWEEP GENERATOR TUBE 351-8	1- CLASS A RANGE SWITCH IN EITHER 20 OR 100 MILE POSITION	PIN 4 CONTROL GRID		
	2- CLASS A SWEEP LENGTH AT NORMAL SETTING	PIN 8 PLATE		
CLASS A SWEEP AMPLIFIER TUBE 352-6	1- CLASS A RANGE SWITCH IN EITHER 20 OR 100 MILE POSITION	PIN 5 PLATE		
	2- CLASS A SWEEP LENGTH AT NORMAL SETTING.	PIN 2 PLATE		

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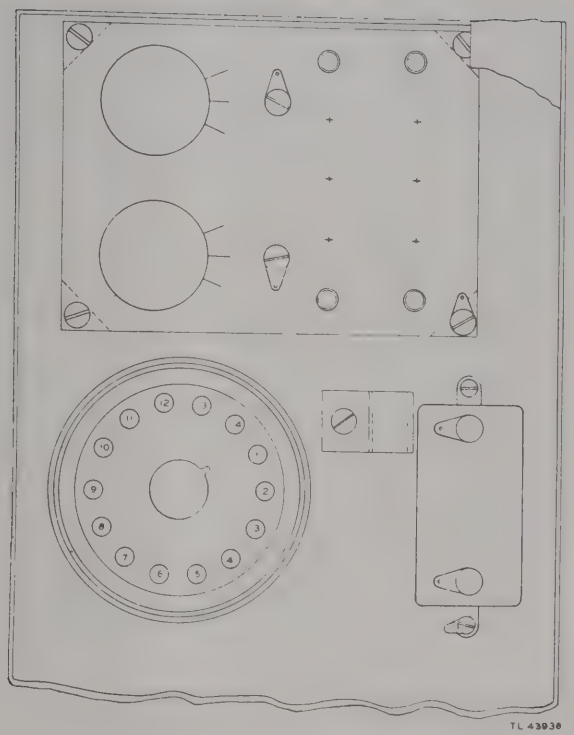
Figure 115. Indicator Unit ID-16/TPS-1A, test waveforms for tubes 351-8 and 352-6.



Resistance Measurements at Vacuum Tube Socket and Equipment Terminals

CLASS A Oscilloscope Socket

Measure				
From		*To*		*Resistance in Ohms*
Equipment	*Terminal*	*Equipment*	*Terminal*	
346	2	346	14	0
*346	2	346	5	630,000
346	2	346	3	1 megohm
*346	5		GRD	860,000
**346	5		GRD	1 megohm
346	9		V6	55,000
346	10	352-6	2	0
346	11	352-6	5	0

* Class A Focus control potentiometer extreme clockwise.
** Class A Focus control potentiometer extreme counterclockwise.

Figure 116. Indicator Unit ID-16/TPS-1A, resistances at Class A oscilloscope tube socket.

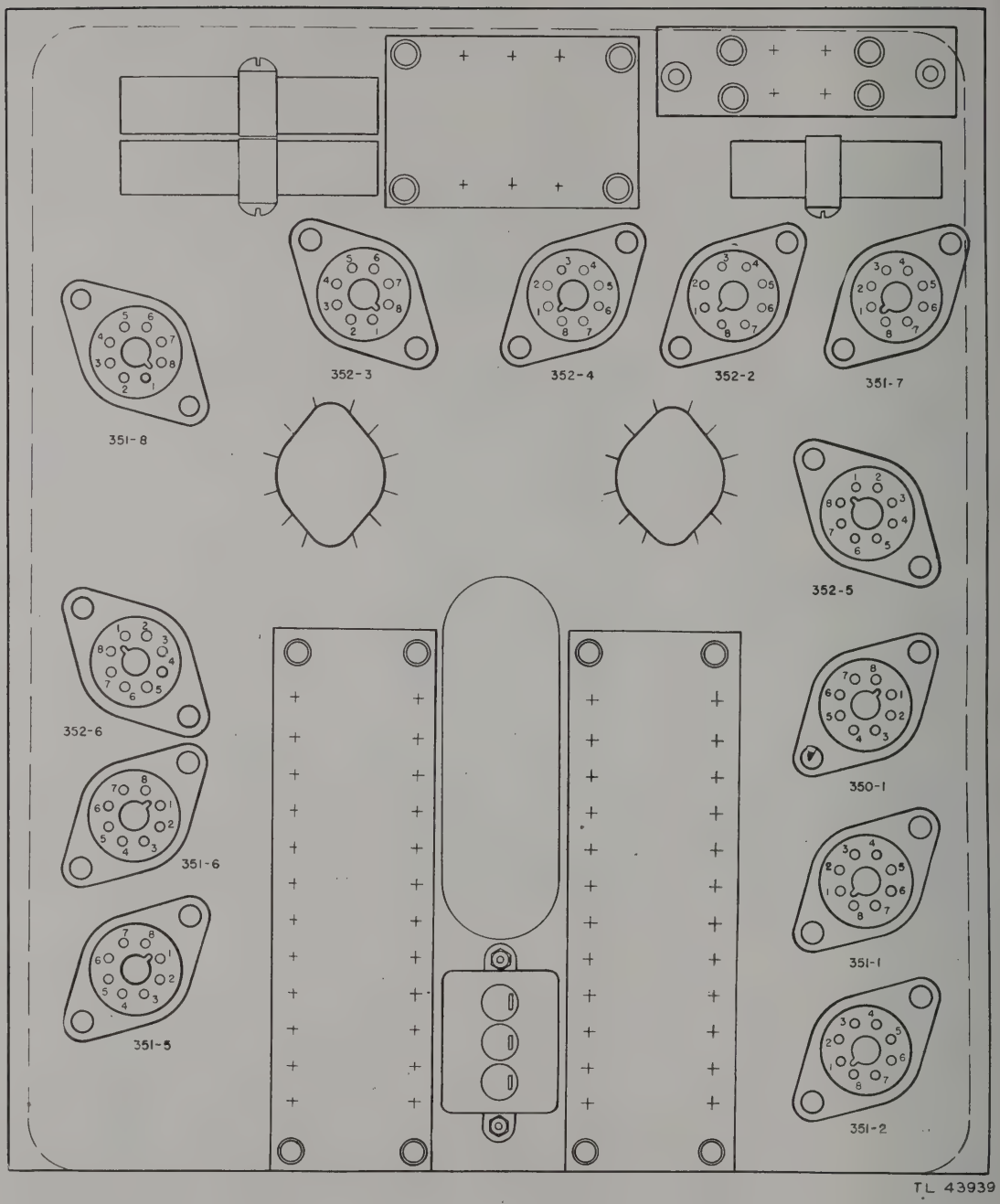


Figure 117. Indicator Unit ID-16/TPS-1A, voltages and resistances of video and sweep chassis.

Typical Voltage Measurements at Vacuum Tube Socket Terminals

	D-C Voltages to Ground from Socket Terminals								
Socket	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*Remarks*
350-1	0	0*	540	300	—33	—	0*	1	No sweep.
	0	0*	520	300	—33	—	0*	2.9	Range switch 20.
	0	0*	520	300	—33	—	0*	5.0	Range switch 60.
351-1	0	0*	6	0	6	115	0*	295	
351-2	0	0*	0	0	0	130	0*	200	
351-5	0	0*	7.5	0	7.5	120	0*	297	
351-6	0	0*	0	0	0	120	0*	195	
351-7	0	0*	0	—0.8	0	77	0*	0.2	No Sweep.
	0	0*	0	—8.2	0	102	0*	2.2	Range switch 20.
	0	0*	0	—24	0	142	0*	5	Range switch 60.
351-8	0	0*	0	—0.5	0	75	0*	—0.1	No sweep.
	0	0*	0	—10	0	95	0*	0.5	Range switch 20.
	0	0*	0	—42	0	187	0*	2.8	Range switch 100.
352-2	73	238	75	44	297	75	0*	0*	No sweep. / Range switch 20.
	69	242	72	44	286	72	0*	0*	Range switch 20.
	60	232	67	44	270	67	0*	0*	Range switch 60.
352-3	72	272	75	44	296	75	0*	0*	No sweep. / Range switch 20.
	69	274	73	44	287	73	0*	0*	Range switch 20.
	52	285	66	44	248	66	0*	0*	Range switch 100.
352-4	63	72	63	67	73	67	0*	0*	No sweep.
	63	69	63	67	69	67	0*	0*	Range switches 20 and 20.
	63	52	63	67	60	67	0*	0*	Range switches 60 and 100.
352-5	0	335	4.3	0.3	270	3.5	0*	0*	No sweep.
	0	322	4.0	2.2	267	6.0	0*	0*	Range switch 20.
	0	320	4.0	5.2	265	9.0	0*	0*	Range switch 60.
352-6	3	122	4.0	—0.2	276	4.3	0*	0*	No sweep.
	2.8	133	4.0	0.5	263	5.0	0*	0*	Range switch 20.
	2.8	165	4.8	2.8	230	6.3	0*	0*	Range switch 100.

* Voltage at these terminals 6.3 volts ac.

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals

Measure From		*To*		*Resistance in Ohms*
Equipment	*Terminal*	*Equipment*	*Terminal*	
		PPI Prepulser		
352-2	4		V8	0
352-2	4		GRD	20,000
352-2	6	352-2	3	0
352-2	3		GRD	27,000
352-2	5		V3	68,000
352-2	2		V7	116,000
*352-2	2		V3	17,000
**352-2	2		V3	23,000

* PPI RANGE switch set to 20.
** PPI RANGE switch set to 60.

Figure 117. Indicator Unit ID-16/TPS-1A, voltages and resistances of video and sweep chassis (contd).

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals (contd)

Measure From		Measure To		Resistance in Ohms
Equipment	*Terminal*	*Equipment*	*Terminal*	
		PPI Prepulser—contd.		
†352-2	1		V3	2.1 megohms
††352-2	1		V3	2.9 megohms
352-2	1	352-4	5	0
352-2	7		V1	0
352-2	8		V2	0
† ADJ. RANGE potentiometer in extreme counterclockwise position.				
†† ADJ. RANGE potentiometer in extreme clockwise position.				
		Sweep Stabilizer		
352-4	1		GRD	55,000
352-4	1	352-4	3	0
352-4	2	352-3	1	0
352-4	4		GRD	55,000
352-4	4	352-4	6	0
352-4	7	352-2	7	0
352-4	8	352-2	8	0
		PPI Sweep Generator		
351-7	1		GRD	0
351-7	2	352-4	8	0
351-7	3		GRD	0
351-7	3	351-7	5	0
351-7	4		GRD	2.0 megohms
351-7	6		V3	45,000
351-7	7	352-4	7	0
351-7	8		V3	2.5 megohms
351-7	8	352-5	4	0
		PPI Sweep Amplifier		
352-5	1		GRD	2.9 megohms
352-5	2		V6	210,000
352-5	3		GRD	4,600
352-5	5		V3	34,000
352-5	6	350-1	8	3,100
352-5	7	351-7	7	0
352-5	8	351-7	2	0
350-1	3		V11	0
350-1	4		V3	0
350-1	5		GRD	750,000
350-1	5		V7	780,000
350-1	2	352-5	8	0
350-1	7	352-5	7	0
*350-1	8		GRD	155
**350-1	8		GRD	350
* PPI SWEEP LENGTH potentiometer in extreme clockwise position.				
** PPI SWEEP LENGTH potentiometer in extreme counterclockwise position.				

Figure 117. Indicator Unit ID-16/TPS-1A, voltages and resistances of video and sweep chassis (contd).

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals (contd)

Measure From		Measure To		Resistance in Ohms
Equipment	*Terminal*	*Equipment*	*Terminal*	
		CLASS A Prepulser		
352-3	1	352-4	2	0
†352-3	1		V3	2.2 megohms
††352-3	1		V3	3.0 megohms
*352-3	2		V3	9,700
**352-3	2		V3	8,200
352-3	2		V15	0
352-3	3		GRD	27,000
352-3	3	352-3	6	0
352-3	4		V8	0
352-3	4		GRD	19,000
352-3	5		V3	70,000
352-3	7		V1	0
352-3	8		V2	0

† CLASS A ADJ. RANGE potentiometer in extreme counterclockwise position.
†† CLASS A ADJ. RANGE potentiometer in extreme clockwise position.
* CLASS A RANGE switch set to 20.
** CLASS A RANGE switch set to 100.

		CLASS A Sweep Generator		
351-8	1		GRD	0
351-8	2	352-3	8	0
351-8	3		GRD	0
351-8	3	351-8	5	0
351-8	4		GRD	2.1 megohms
351-8	6		V3	47,000
351-8	7	352-3	7	0
351-8	8	352-6	4	0
*351-8	8		V3	2.5 megohms
**351-8	8		V3	3.3 megohms

* CLASS A SWEEP LENGTH potentiometer in extreme clockwise position.
** CLASS A SWEEP LENGTH potentiometer in extreme counterclockwise position.

		CLASS A Sweep Amplifier		
*352-6	1		GRD	0
**352-6	1		GRD	4,000
352-6	2		V13	220,000
352-6	3		V7	170,000
352-6	3	352-6	6	5,500
352-6	5		V13	210,000
352-6	7	351-8	7	0
352-6	8	351-8	2	0

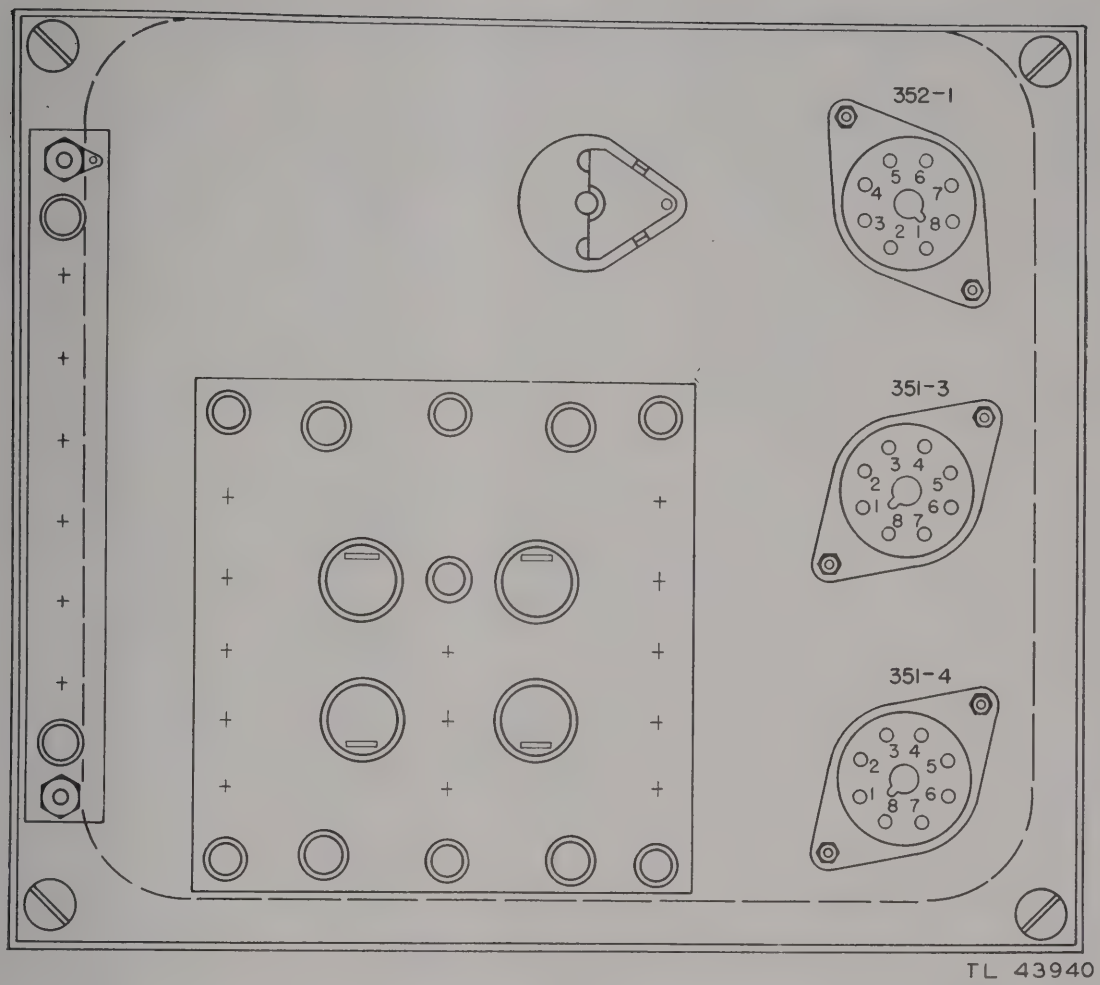
* CLASS A HORT CENT potentiometer in extreme clockwise position.
** CLASS A HORT CENT potentiometer in extreme counterclockwise position.

Figure 117. Indicator Unit ID-16/TPS-1A, voltages and resistances of video and sweep chassis (contd).

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals (contd)

Measure From		Measure To		Resistance in Ohms
Equipment	*Terminal*	*Equipment*	*Terminal*	
		PPI Video Amplifier 1		
351-1	1		GRD	0
351-1	2		V2	0
351-1	3	351-1	5	0
351-1	3		GRD	2,600
351-1	4		GRD	330,000
351-1	5	351-1	6	36,000
351-1	6		V3	38,000
351-1	7		V1	0
351-1	8		V3	14,500
		PPI Video Amplifier 2		
351-2	1		GRD	0
351-2	2	351-1	2	0
351-2	3		GRD	0
351-2	3	351-2	5	0
351-2	4		GRD	330,000
351-2	6		V3	55,000
351-2	7	351-1	7	0
351-2	8		V3	10,000
		CLASS A Video Amplifier 1		
351-5	1		GRD	0
351-5	2		V2	0
351-5	3	351-5	5	0
351-5	3		GRD	3,800
351-5	4		GRD	330,000
351-5	5	351-5	6	35,000
351-5	6		V3	38,000
351-5	7		V1	0
351-5	8		V3	15,000
		CLASS A Video Amplifier 2		
351-6	1		GRD	0
351-6	2	351-5	2	0
351-6	3		GRD	0
351-6	3	351-6	5	0
351-6	4		GRD	330,000
351-6	6		V3	55,000
351-6	7	351-5	7	0
351-6	8		V3	10,500

Figure 117. Indicator Unit ID-16/TPS-1A, voltages and resistances of video and sweep chassis (contd).



Typical Voltage Measurements at Vacuum Tube Socket Terminals

CAUTION: INDICATOR UNIT ID-16/TPS-1A HAS A POTENTIAL OF ABOUT 5000 VOLTS AT THE HIGH-VOLTAGE RECTIFIER CIRCUIT.

D-C Voltages to Ground from Socket Terminals

Socket	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
351-3	0	0*	0	—10.3	0	0	0*	0
351-3**	0	0*	0	—10.3	0	115	0*	297
351-4	0	0*	0	—10.3	0	0	0*	0
351-4***	0	0*	0	—10.3	0	115	0*	297
352-1	133	297	145	— 0,4	132	0.25	0*	0*

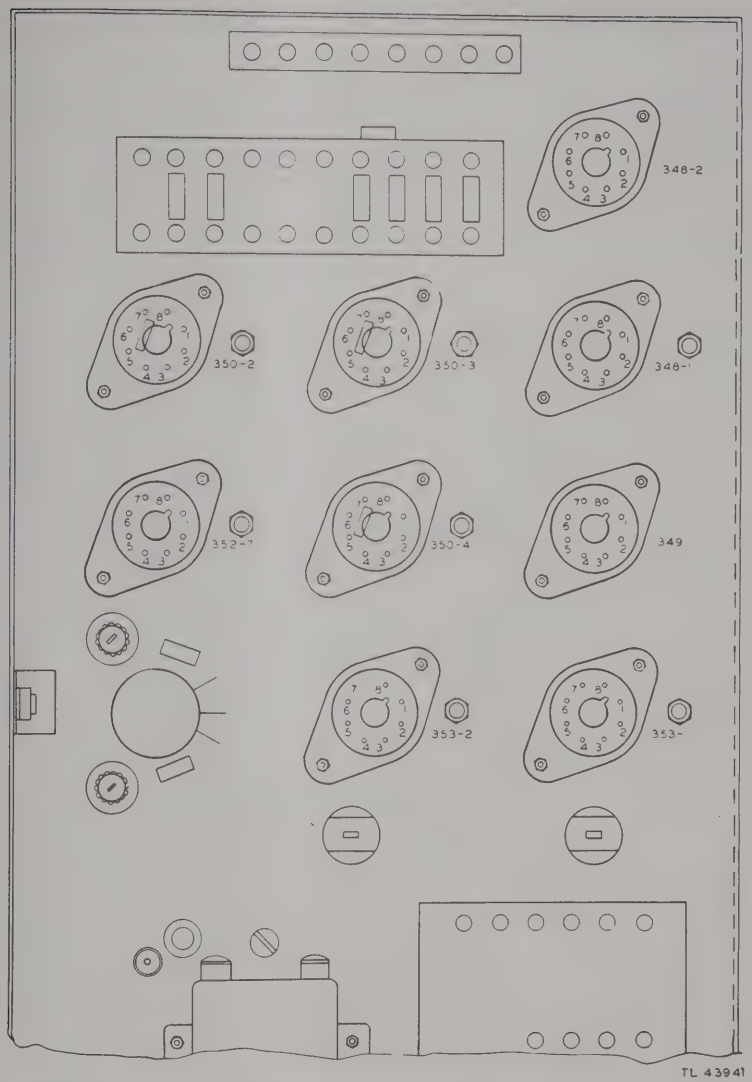
* Voltage at these terminals 6.3 volts ac.
** PPI RANGE MARKER button pressed.
*** CLASS A RANGE MARKER button pressed.

Figure 118. Indicator Unit ID-16/TPS-1A, voltages and resistances of range marker chassis.

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals

Measure				*Resistance in Ohms*
From		*To*		
Equipment	*Terminal*	*Equipment*	*Terminal*	
	M1		GRD	0
	M2	352-1	7	0
	M2	351-3	7	0
	M2	351-4	7	0
	M3	352-1	8	0
	M3	351-3	2	0
	M3	351-4	2	0
	M5	352-1	2	10,500
	M6	352-1	6	82,000
	M7	351-3	8	18,000
	M7		GRD	300,000
	M8	351-4	8	10,000
	M8		GRD	300,000
		Marker Generator		
352-1	4		GRD	100,000
352-1	3		GRD	3.3 megohms
352-1	1		GRD	22,000
		PPI Marker Amplifier		
351-3	3	351-3	5	0
351-3	1	351-3	5	0
351-3	1		GRD	0
351-3	6		GRD	120,000
351-3	4	351-4	4	0
		CLASS A Marker Amplifier		
351-4	3	351-4	5	0
351-4	1	351-4	5	0
351-4	1		GRD	0
351-4	6		GRD	120,000

Figure 118. Indicator Unit ID-16/TPS-1A, voltages and resistances of range marker chassis (contd).



Typical Voltage Measurements at Vacuum Tube Socket Terminals

	D-C Voltages to Ground from Socket Terminals							
Socket	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
348-1	0	540*	—	—1	—	—1	—	540*
348-2	0	540*	—	—1	—	—1	—	540*
349	—	—1.2**	—340	—	—340	—	—1.2**	—1.2
350-2	0	220**	540	540	280	—	220**	300
350-3	0	220**	540	540	280	—	220**	300
350-4	0	220**	540	540	280	—	220**	300
352-7	190	280	195	143	187	150	220**	220**
353-1	—	—150	—	—	0	—	—	—
353-2	—	150	—	—	300	—	—	—

* Voltage at these terminals 5 volts ac.
** Voltage at these terminals 6.3 volts ac.

Figure 119. Indicator Unit ID-16/TPS-1A, voltages and resistances of power chassis.

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals

Measure From		Measure To		Resistance in Ohms
Equipment	*Terminal*	*Terminal*	*Equipment*	
		300-Volt Regulated Rectifier		
348-1	1		GRD	0
348-1	2	348-2	2	0
348-1	4	348-1	6	0
348-1	6	348-2	6	17
348-1	8	348-2	8	0
348-2	1		GRD	0
348-2	4	348-2	6	0
348-2	6	349	8	0
348-2	8		P1	32
		—150-Volt Rectifier		
349	2	349	8	0
349	3	349	5	0
349	5		P11	20,000
349	7	349	2	0
		—150-Volt Regulator		
353-1	2		P11	0
353-1	5		GRD	0
		300-Volt Regulating Tubes		
350-2	1		GRD	0
350-2	2	350-3	2	0
350-2	2	350-2	1	280,000
350-2	3	350-2	4	47
350-2	3		P1	47
350-2	5	352-7	2	470
350-2	7	350-3	7	0
350-2	8		P22	0
350-2	8		P1	2,700
350-2	2	350-2	7	0
350-3	1		GRD	0
350-3	2	350-4	2	0
350-3	3	350-3	4	47
350-3	3		P1	47
350-3	5	352-7	2	470
350-3	7	352-7	8	0
350-3	8	350-2	8	0
350-4	1		GRD	0
350-4	2	352-7	7	0
350-4	3	350-4	4	47
350-4	3		P1	47
350-4	5	352-7	2	470
350-4	7	352-7	8	0
350-4	8	350-3	8	0

Figure 119. Indicator Unit ID-16/TPS-1A, voltages and resistances of power chassis (contd).

Resistance Measurements at Vacuum Tube Socket and Equipment Terminals (contd)

Measure From		*Measure* To		*Resistance in Ohms*
Terminal	*Equipment*	*Equipment*	*Terminal*	
		300-Volt Regulator Amplifier		
352-7	1	352-7	5	470
352-7	5	350-4	8	470,000
352-7	6	353-2	2	0
353-2	5	350-4	8	0
Terminal	P3		P21	0
strip	P4		P20	0
	P10		P14	0
	P10		GRD	OPEN
	P6		P16	90
	P7		P22	0
	P17		P18	0
	P18		P19	0
	P19		P16	0
	P20		P21	0
	P23	353-1	2	470,000

Figure 119. Indicator Unit ID-16/TPS-1A, voltages and resistances of power chassis (contd).

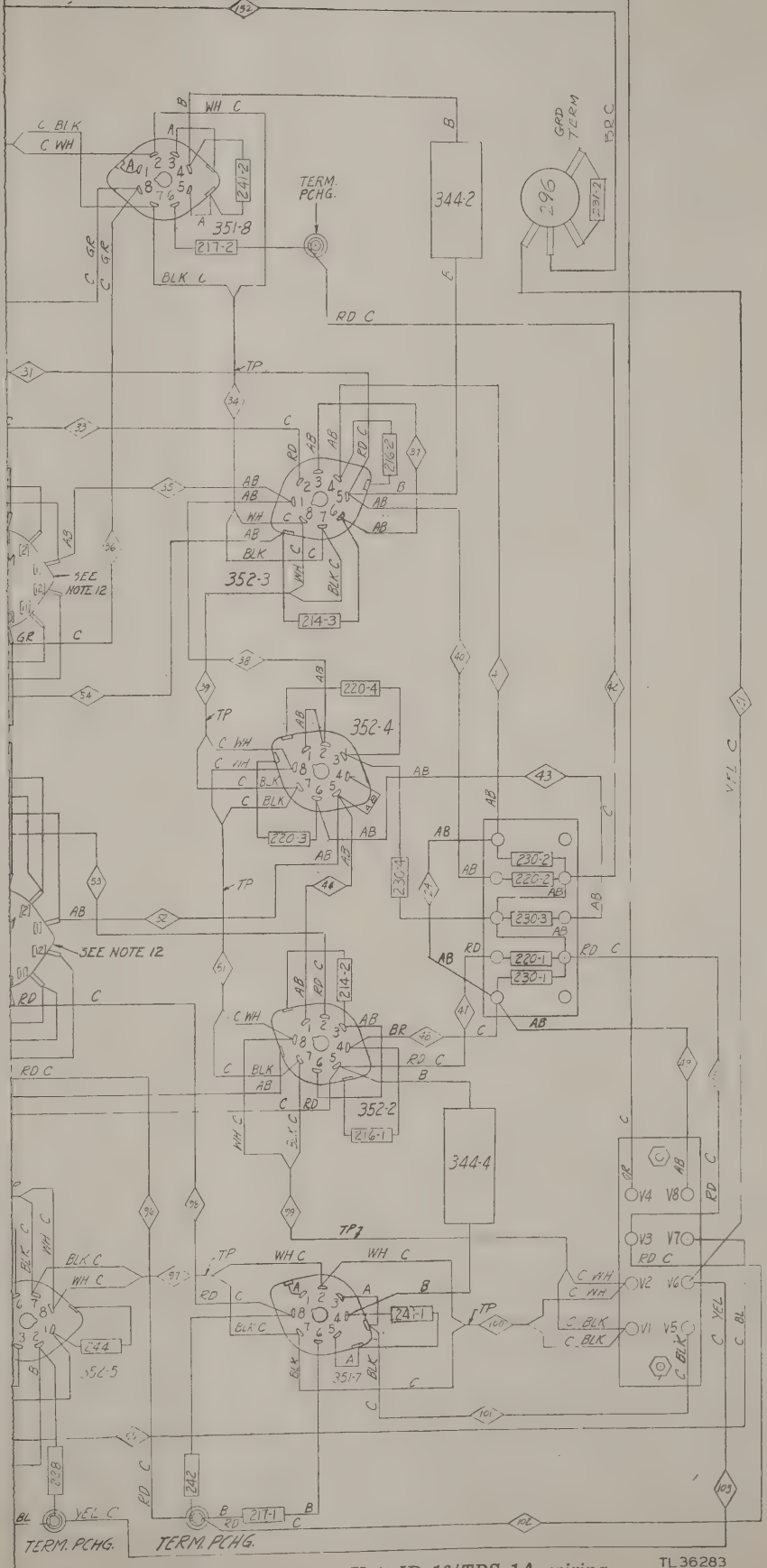


Figure 120. Indicator Unit ID-16/TPS-1A, wiring

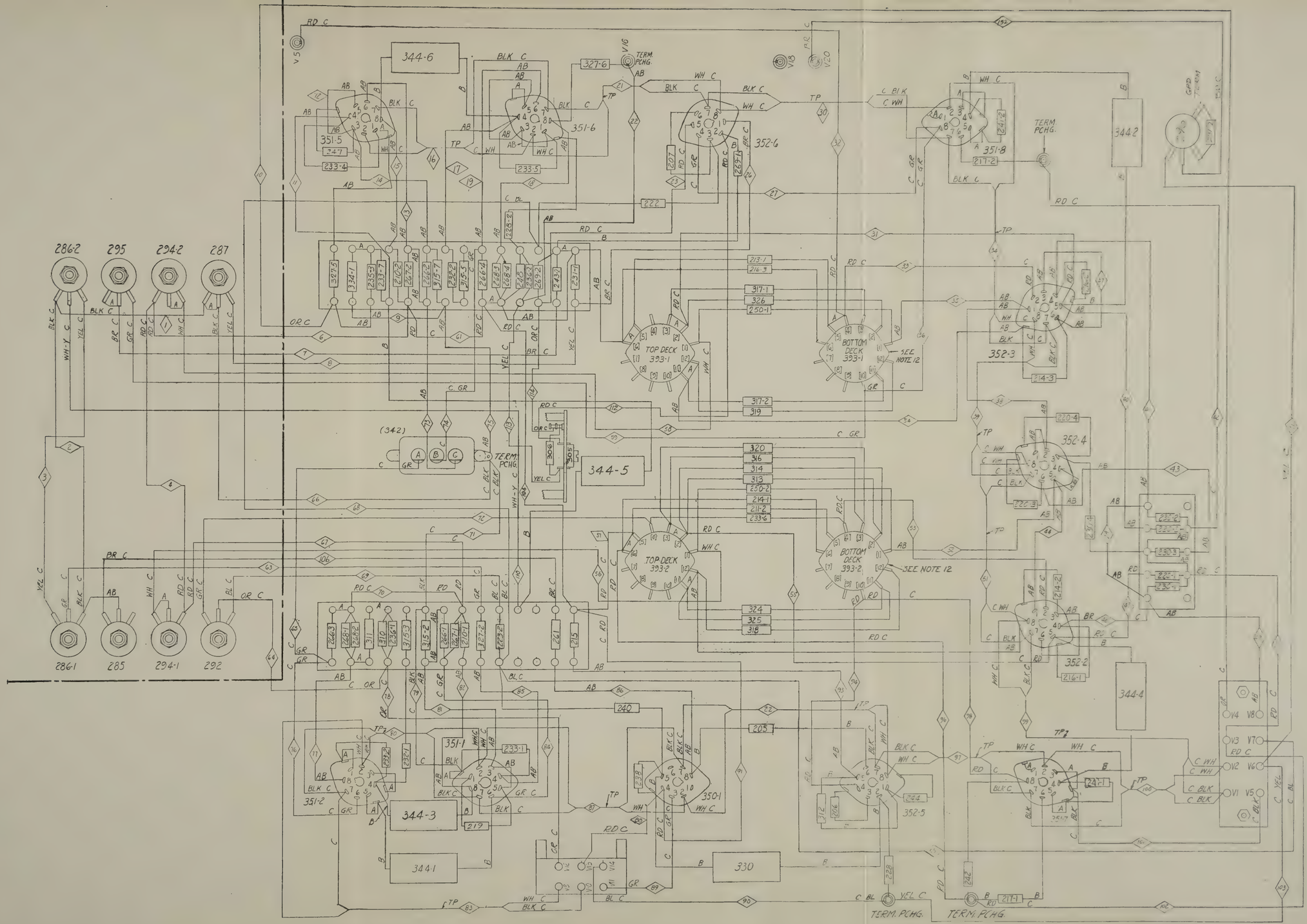


Figure 120. Indicator Unit ID-16/TPS-1A, wiring diagram of video and sweep chassis.

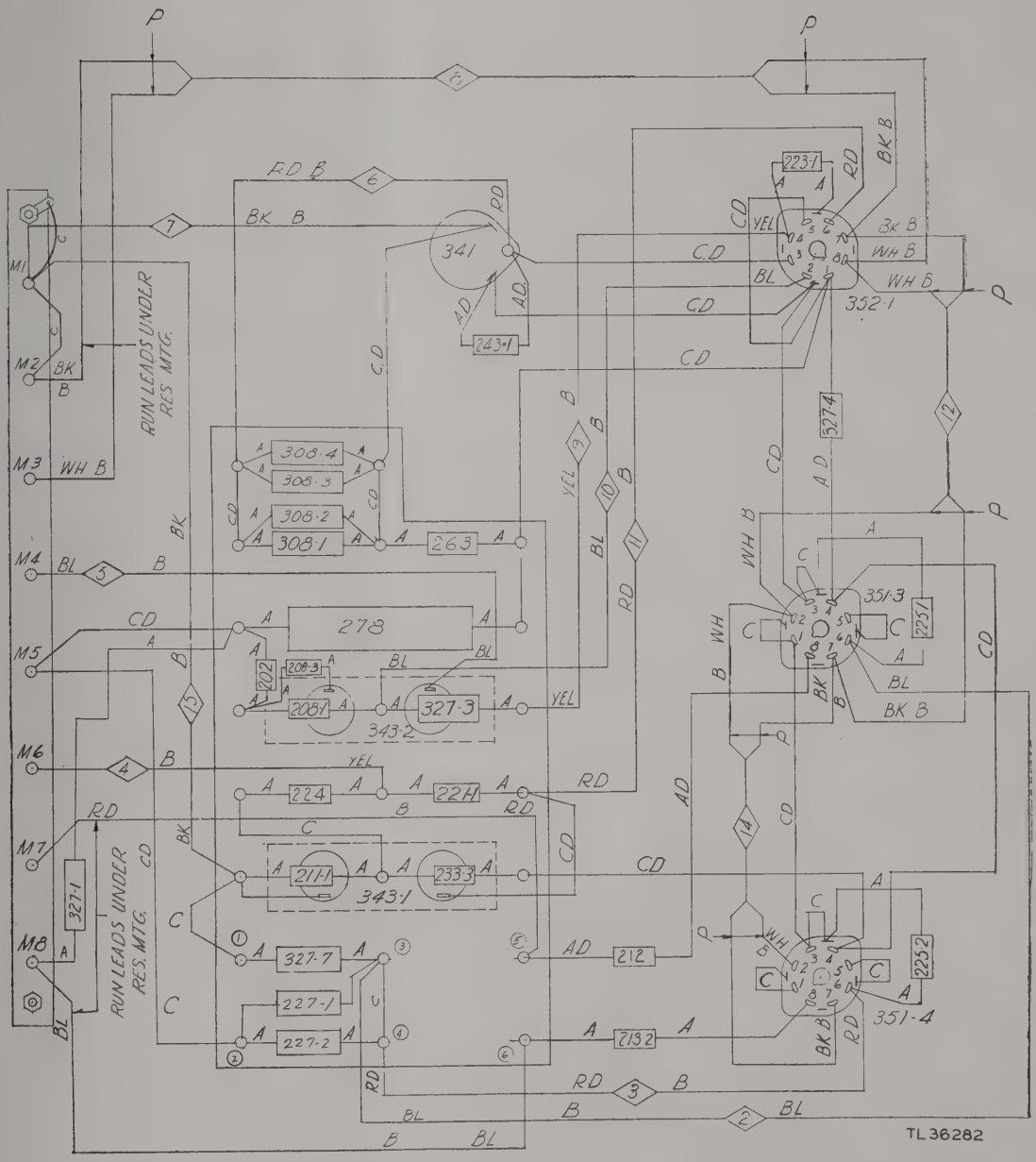


Figure 121. Indicator Unit ID-16/TPS-1A, wiring diagram of range marker chassis.

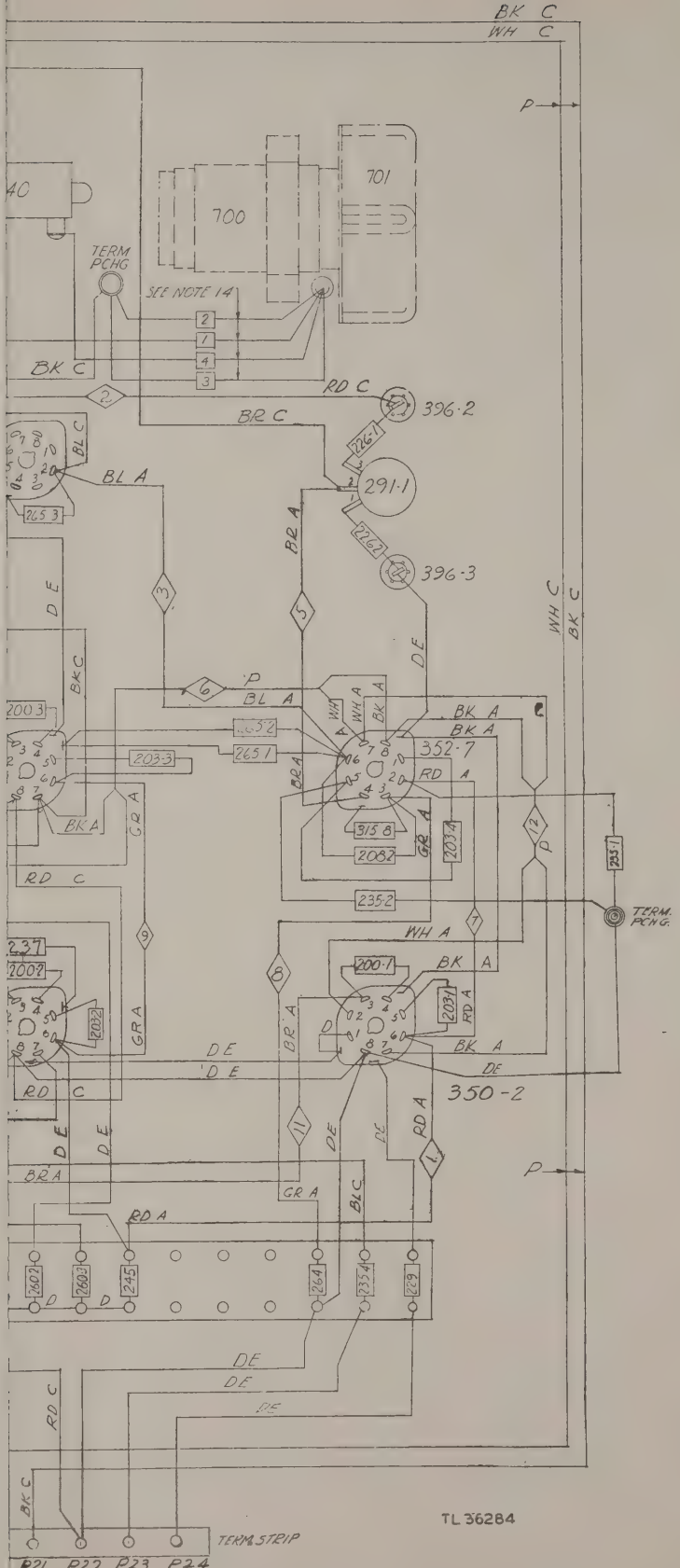


Figure 122. Indicator Unit ID-16/TPS-1A, wiring diagram of power chassis.

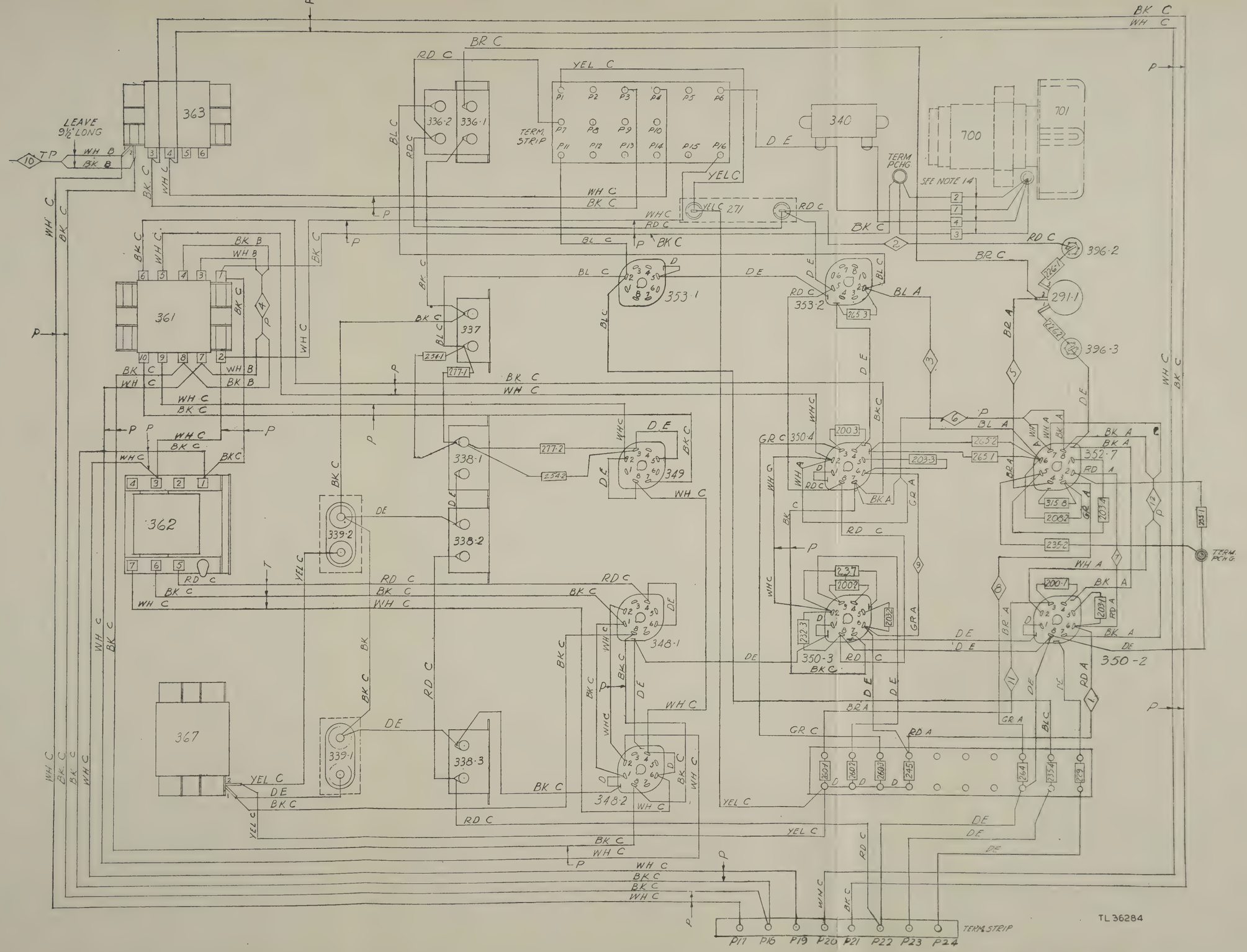


Figure 122. Indicator Unit ID-16/TPS-1A, wiring diagram of power chassis.

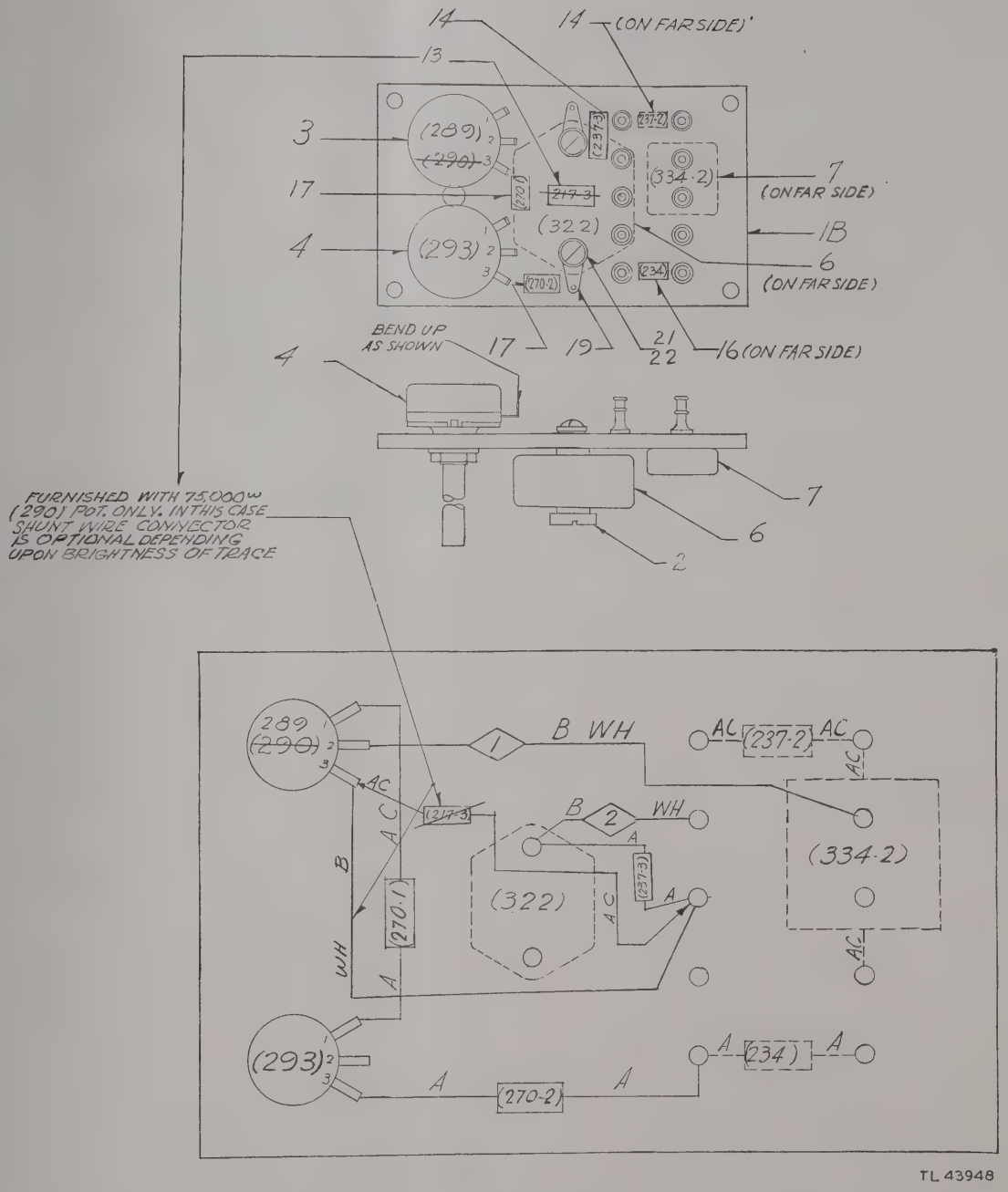


Figure 123. Indicator Unit ID-16/TPS-1A, wiring diagram of Class A insulator assembly.

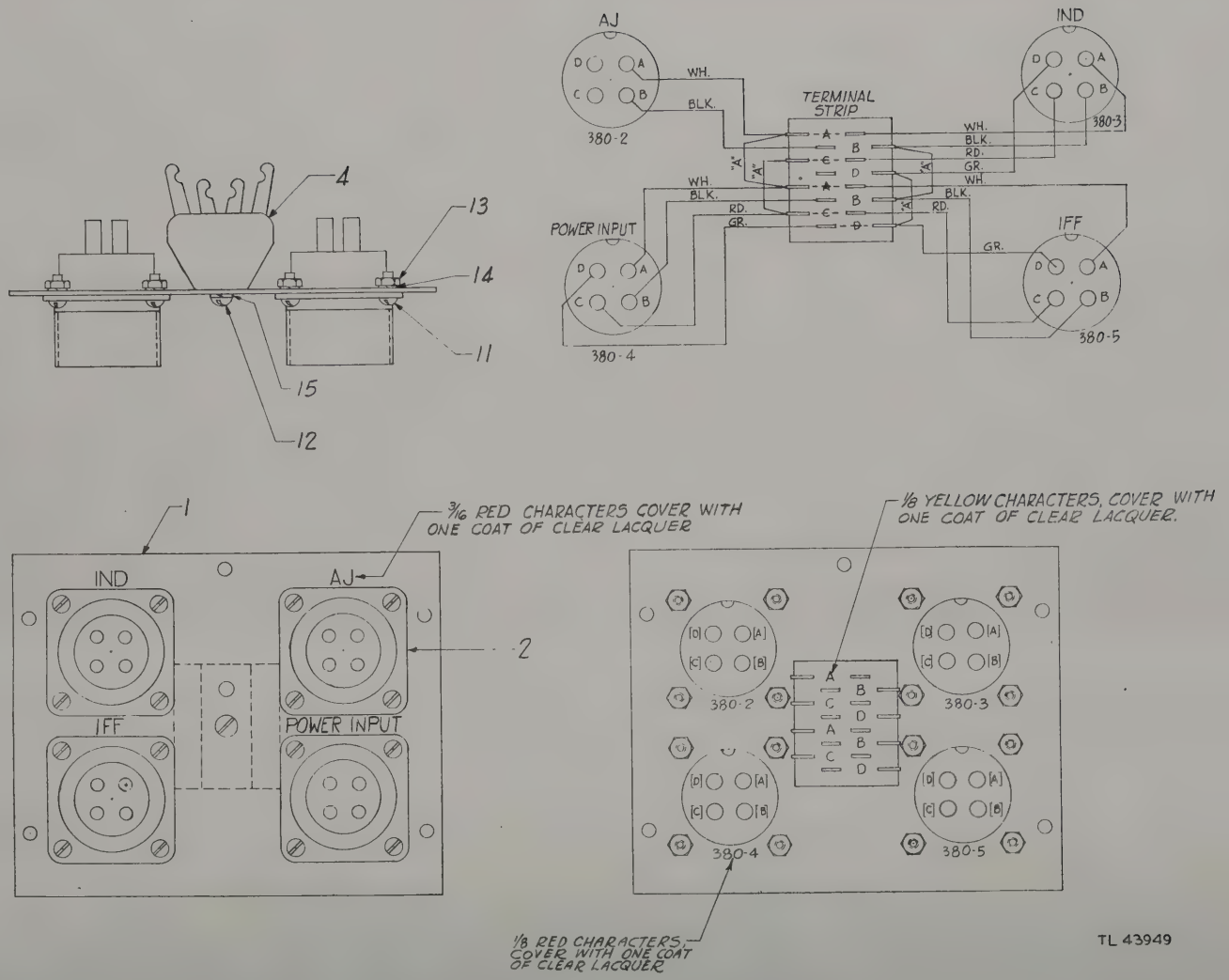
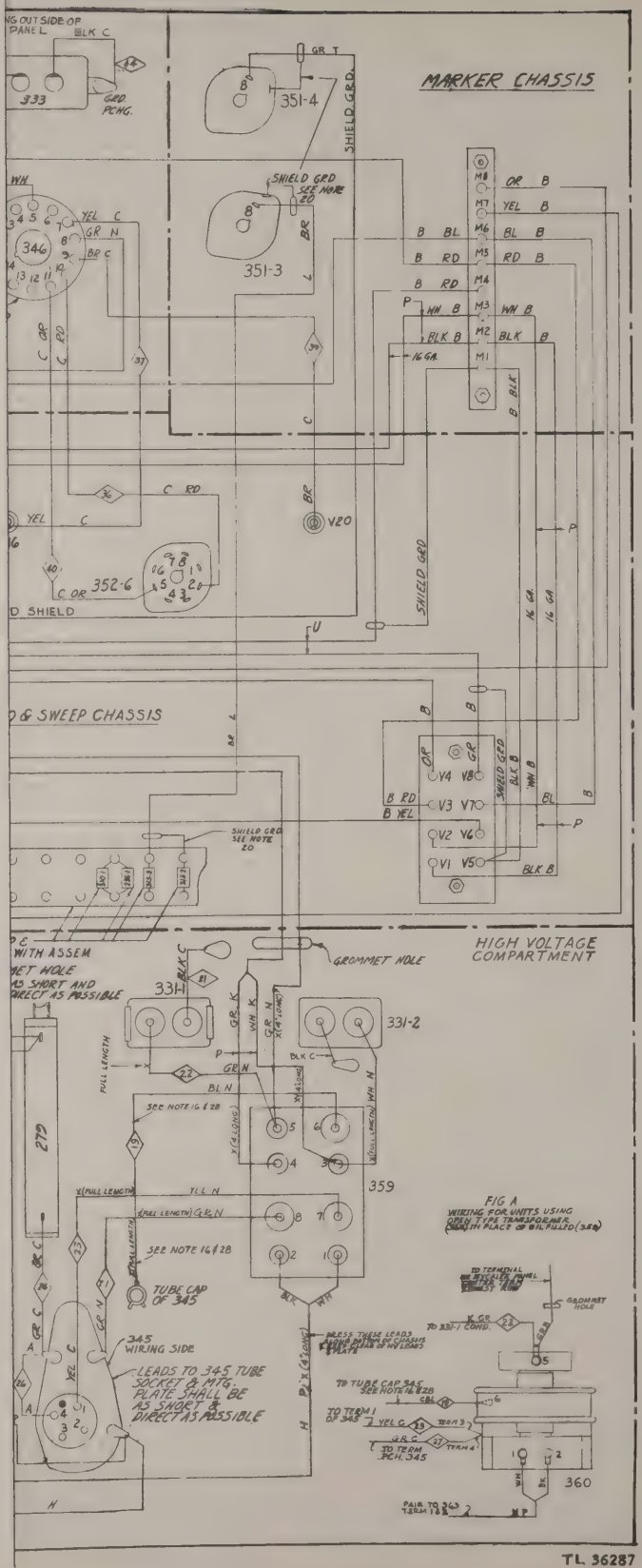


Figure 124. Power connector, wiring diagram.



cator Unit ID-16/TPS-1A,
ring diagram

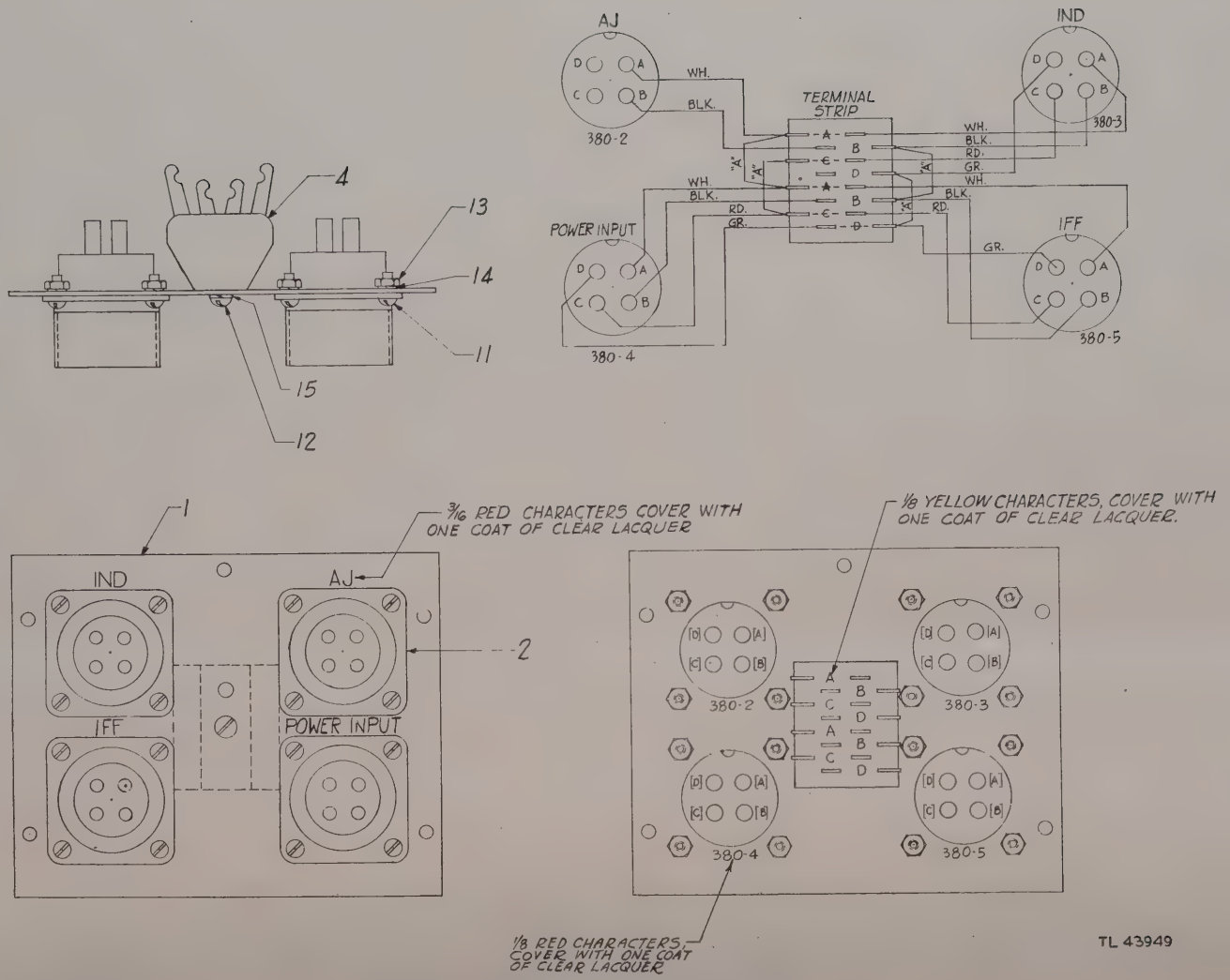


Figure 124. Power connector, wiring diagram.

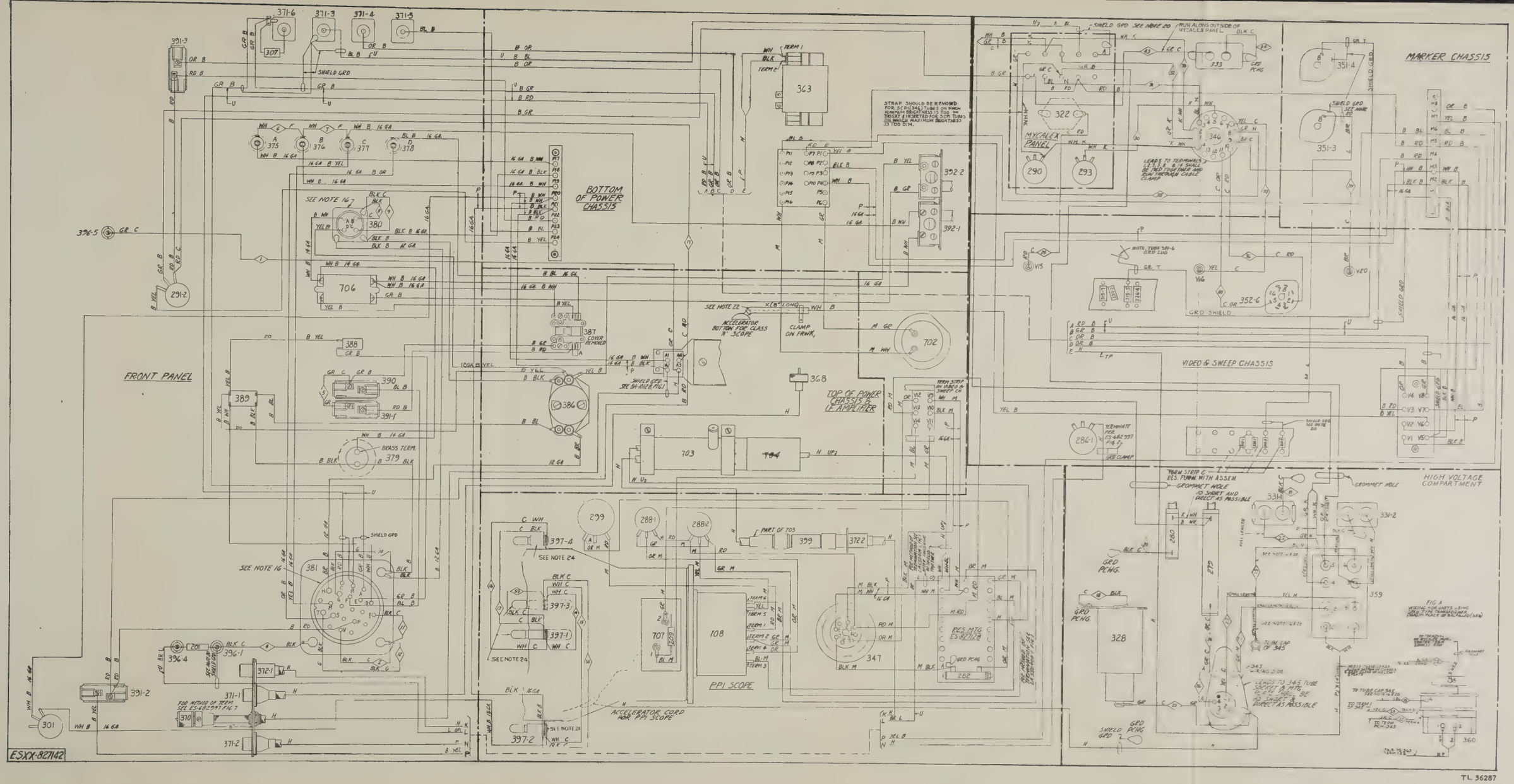


Figure 125. Indicator Unit ID-16/TPS-1A, wiring diagram

CHAPTER 3

MAINTENANCE PARTS LIST

73. INDEX TO EQUIPMENT.

Major Item	*Symbol*
Antenna AS-8/TPS-1	A
Antenna Carrying Case	ACC
Antenna Drive Unit C-14/TPS-1	AD
Connecting Cables and Flexible Shaft	CC&FS
Control Unit C-13/TPS-1	C
Indicator Unit ID-16/TPS-1A	I
Miscellaneous Tower Parts	MTP
Modulator Unit MD-2/TPS-1	M
Radio-Frequency Unit RF-1/TPS-1	RF

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A.

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	2ZK261.3	I	ADAPTER: brass; 1-3/16″ lg x 0.420″ OD x 0.309″ ID; four slots on one end, shoulder on other; D-163664, Western Electric Co.	1	*				*
12	3F903-1	RF	AMMETER: d-c; ASA type MR35W030DCMA; (0-30 milliampere; calibrated for use on non-magnetic panel).	1	*				*
385	2CH63-1	I	AMPLIFIER: i-f; including tubes; D-150951, Western Electric Co.	1					*
	2C461	RF	AMPLIFIER ASSEMBLY: less tubes; Western Electric Co ES-803911.	2					*
	5B181A	MTP	ANCHOR: steel, wing; ES-827163.	4	*				*
	2C1565-12/D1	I	ANGLE DRIVE ASSEMBLY: WE ESO-804218-1; (steel; over-all dimen approx 1-5/16″ x 2″ x 3/4″ diam; consists of pair of brass miter gears assembled in right-angle housing 1-5/16″ x 1″ x 3/4″ OD).	1	*				*
	2A264-8/A1		ANTENNA AS-8/TPS-1: Western Electric Co No. X-71605P.	1					*
	2A392		ANTENNA CARRYING CASE: Western Electric Co No. X-61705Q.	1					*
	2A990.14		ANTENNA DRIVE UNIT C-14/TPS-1: Western Electric Co No. X-61705N.	1					*
	3H963/A1	AD	ARMATURE: for KS-5860, L1 magnetic clutch, WE Co.	1					*
	2Z558-3	RF	BAR: phosphor-bronze; 0.005″ thk, 2-1/4″ x 1-1/6″ before bending; part of plunger assembly; ES-803927-2, WE Co.	2					*
	3H304-11	AD	BEARINGS: set; for KS-5807, LO3 ventilating unit; type ND77R6, Ohio Elec & Mfg Co.	1					*

	3H304-12	AD	BEARING: cartridge; type LCJ, for 2-3/16″ shaft; Fafnir Bearing.	1						*
	3H304-9	AD	BEARING: ball; Fafnir 37KDD, (Federal 9433FF, New Departure 77037, MRC37FF, Norma-Hoffman C97; for oscillator tuning mechanism).	1						*
	3H4575A/199	AD	BEARING: shaft end; for KS-5845, LO1 motor; type ND7503, New Departure.	1						*
	2C2537-2/B2	M	BLADDER ASSEMBLY: rectangular; rubber; 5-1/4″ long x 3-3/4″ wide; BO-30524-1, WE Co.	1						*
	2C2537-2/B3	M	BLADDER ASSEMBLY: rectangular; rubber; 8-3/4″ x 3-3/4″; BO-30524-4, WE Co.	1						*
16	4E926	RF	BLOCK: protector; type 26, WE Co.	1						*
17	4E927	RF	BLOCK: protector; type 27, WE Co.	1						*
	2A99-14/B1	AD	BOLT ASSEMBLY: capstan; steel; 4″ x 1-5/8″; ES-825083-5, WE Co.	1						*
	6L485-1	AD	BOLT: sockethead steel; stripper; 5/16-18-3/8″ x 1″.	4						*
	3H3100A16-2/B22	AD	BRUSH ASSEMBLY: for KS-5845, LO1 motor; type 4-a-491, Diehl.	2					*	*
	3H3100A16-2/H10	AD	BRUSHES AND BRUSH HOLDER: set; for KS-5860, L1 magnetic clutch.	1						*
	3H3100A16-2/B20	AD	BRUSHES: set of 4; for KS-5807, LO3 ventilating unit, type 5689, Ohio Elec & Mfg.	1					*	*
	2Z1410-1	I	BUSHING: brass; WE ESO-804027-5; (cylindrical; over-all lgth 7/16″ including 1/16″ x 9/16″ diam head at one end, drilled to accommodate 1/4″ shaft).	10						*
	2Z1410	I	BUSHING: brass; WE ESO-804027-6; (over-all lgth 5/16″ including 1/16″ x 1/2″ hex head on one end, drilled to accommodate 1/4″ diam shaft).	7						*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	2Z1409-8	I	BUSHING: potentiometer; steel; 0.625″ diam x 5/16″ wide; ES-804066-5, WE Co.	12					*
	2Z1409-7	RF	BUSHING: brass; WE Co ES-804140-2; (made of one piece in three sections).	1					*
	1F4W1-3.60	RF	CABLE: coaxial; WE Co ES-804159-1; (consists of a silver-plated brass hood D-162986; coaxial jack D-164459; coaxial jack D-163447; coaxial cable D-163296; 24″ lg).	1					*
	1F4W1-3.30	RF	CABLE: coaxial; WE Co ES-804159-2; (consists of coaxial cable D-163296, 13″ lg; on one end jack D-163474, on other end plug D-163446).	1					*
	1F4W1-3.60	I	CABLE: coaxial; No. 17 AWG; solid black with white tracer; OD 0.312″, 14-1/2″ long; type D-163296, WE.		*				*
	1F4W1-28.1.125	I	CABLE ASSEMBLY: coaxial; WE Co dwg ES-804130-6 (consists of coaxial cable D-163296 1-1/8″ lg; on both ends a jack D-163474).	1	*				*
	1F4G2-1	RF	CABLE: coaxial; microwave; GE Co; (No. 16 AWG; solid; copper; 0.185 OD over dielectric; 2 braids of No. 34 wire shielding, vinylite sheath).	2-1/12					*
	1F4W1-23.15.5	RF	CABLE ASSEMBLY: 1 ft 3-1/2″ lg; WE No. D-164190; rubber insulation; (No. 14 AWG; solid; R.C., braided No. 36 wire shielding; one end terminating in a jack).	1					*
	1F4W1-22.19.5	RF	CABLE ASSEMBLY: 19-1/2″ lg; WE ES-804140-4; (one RMA No. 16 or GE; No. 15 microwave cable, with one D-163472 coaxial plug).	1					*

	3E6000-69	CC & FS	CABLE ASSEMBLY: 4-conductor; 50′ long; connects power unit to indicator; blue ES-804131-1, Western Electric Co.	1					*
	3E6000-70	CC & FS	CABLE ASSEMBLY: 8-conductor; red; 10′ long; connects r-f unit to modulator; ES-804131-2, Western Electric Co.	1					*
	3E6000-71	CC & FS	CABLE ASSEMBLY: 16-conductor; orange; 7′ long; connects indicator to r-f unit; ES-804131-3, Western Electric Co.	1					*
	3E6000-72	CC & FS	CABLE ASSEMBLY; 4-conductor; white; 3′ long; connects r-f unit to drive head; ES-804131-4, Western Electric Co.	1					*
	1F430-38	CC & FS	CABLE ASSEMBLY: coaxial; yellow; 8′ long; connects r-f unit to indicator; ES-804131-5, Western Electric Co.	1	*			*	*
	1F430-39	CC & FS	CABLE ASSEMBLY: coaxial; green; 8′ long; connects indicator to r-f unit; ES-804131-6, Western Electric Co.	1	*			*	*
	1F430-40	CC & FS	CABLE ASSEMBLY: coaxial; silver; 12′ long; connects modulator to r-f unit; ES-804131-8, Western Electric Co.	1					*
	1F4W1-24.20.5	RF	CABLE LINE ASSEMBLY: WE Co ESR-804219-1; (consists of inner and outer coaxial conductor assemblies, connected to form a coaxial line assembly straight section with 2 branches at right angles, straight section 20-1/2″ x 1-5/8″ OD over-all, Bolton branches 13-51/64″ and 5-1/32″ lg).	1					*
	3H3100A16-2/B21	AD	CAP: brush; for KS-5845, LO1 motor; type 4-A-472, Diehl.	2				*	*
147	3DB1.6100E	M	CAPACITOR: 1-mf ±20%; 300-vdcw; paper; DYR-6100, Cornell-Dubilier.	1	*		*	*	*
27	3D9005-19.2	RF	CAPACITOR: ceramic; 5-mmf; 500-vdcw; ±5%; Erie NPOK; zero temperature coefficient.	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
20-1 through 20-4	3D9120-5	RF	CAPACITOR: ceramic; 120-mmf max, 60-mmf min, at 20 kc; 500-vdcw; WE Co D-162582; −40° C at +95° C ambient temperature.	4	*		*	*	*
32	3D9500-88	RF	CAPACITOR: paper; 350-mmf min, 500-mmf max; 25,000-vdcw; WE Co D-166066; fixed; high-voltage terminal on top of cases.	1	*		*	*	*
144	3K2047111	M	CAPACITOR: mico; 470-mmf ±10%; 500-vdcw; ASA CM20A471K, Dubilier 5W, Aerovox 1468.	1	*		*	*	*
33-1 through 33-6	3D9500-87	RF	CAPACITOR: ceramic; 500-mmf ±5%; 500-vdcw; Erie N4 70F; negative temperature coefficient 0.000470 mmf/mmf/degree C.	6	*		*	*	*
67	3D9500-89	RF	CAPACITOR: ceramic; 500-mmf ±10%; 500-vdcw; Erie N7 50D; negative temperature coefficient 0.00075 mmf/mmf/degree C.	1	*		*	*	*
26-1 through 26-6	3K2051112	RF	CAPACITOR: mica; 510-mmf ±5%; 500-vdcw; ASA CM20A511J, Dubilier 5W, Aerovox 1468.	6	*		*	*	*
69-1 69-2	3DKA1-110	RF	CAPACITOR: ceramic; 1,000-mmf ±20%; 300-vdcw; Muter 20K1200, RCA K-97653-1.	2	*		*	*	*
40-1 40-2	3DA3-34	RF	CAPACITOR: paper: 3,000-mmf; WE Co 404B; 800-vdcw; ±20%; mineral-oil impregnated; −40° to +185° F ambient temperature.	2	*		*	*	*
143	3DA10-158	M	CAPACITOR: paper; 10,000-mmf; 400-vdcw; +20% −10%; WE Co 404C; mineral-oil impregnated.	1	*		*	*	*
34-1 34-2 34-3	3DA10-143.4	RF	CAPACITOR: paper; 10,000-mmf ±20%; 600-vdcw; Aerovox No. 689; moisture-resistant; hermetically sealed; oil-filled.	3	*		*	*	*

37	3DA100-158	RF	CAPACITOR: paper; 100,000-mmf ±15%; 250-vdcw; WE Co D-163150; hermetically sealed; oil-filled; cylindrical glass tube with metal end caps.	1	*		*	*	*
142	3DA100-133.9	M	CAPACITOR: 100,000-mmf ±20%; 600-vdcw; paper; Dubilier DYR-601.	1	*		*	*	*
30	3DA100-133.7	RF	CAPACITOR: paper; 2-section; 100,000 mmf —100,000-mmf; +20% −10%; 600-vdcw.	1	*		*	*	*
140	3DA100-104.1	M	CAPACITOR: paper; 100,000-mmf; ±20%; Dubilier DYR-10010; (fixed; moisture-resistant; oil-filled metal case; 2 projecting solder terminals).	1	*		*	*	*
141	3DA100-100.2	M	CAPACITOR: 100,000-mmf ±20%; 1,200-vdcw; paper.	1	*		*	*	*
68	3DA250-20	RF	CAPACITOR: paper; Dykanol-filled and impregnated; 250,000-mmf; 600-vdcw; +20% −10%; Dubilier DYR-6022; (fixed; metal can; three rivet lug terminals on side).	1	*		*	*	*
145	3DKA250-57	M	CAPACITOR: foil paper; 250,000-mmf; 2,000-vdcw; ±10%; Dubilier TJH200025; ESA-682057-11; (fixed; Dykanol "A" impregnated and filled case; screw spade lug mounting brackets).	1	*		*	*	*
117	3DA-500-106	M	CAPACITOR: paper; dual; 500,000 — 500,000-mmf; 1,200-vdcw; ±10%; WE Co D-163708; (fixed; hermetically sealed metal case two projecting high-voltage terminals from top of case; mounted in any position by four No. 8-32 threaded studs 1/2" length, 3/4" x 1-3/4" centers).	1	*		*	*	*
146 31	3DA500-97.2	M RF	CAPACITOR: paper: 500,000-mmf +20% −5%; 600-vdcw; Dubilier DYR-6050; moisture-resistant; Dykanol "A" impregnated.	2	*		*	*	*
307	3K2010111	I	CAPACITOR: mica; 100-mmf ±10%; 500-vdcw; fixed; type Dubilier CM20A101K.	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
413-1 through 413-3	3K2010124	I	CAPACITOR: mica; 100-mmf; 500-vdcw; ±20%; ASA CM20B101M (fixed; molded low-loss bakelite case 15/64″ long x 15/32″ wide 7/32″ thick; two 1-1/8″ No. 20 AWG lead-alloy coated pigtail leads; ASA spec C75.3-1942).	3	*		*	*	*
335-1 335-2	3D9120-5	I	CAPACITOR: ceramic; 120-mmf max, 60 mmf min; fixed; 500-vdcw; type D-162582, WE Co, ASA type CM20B101M.	2	*		*	*	*
312	3K2020133	I	CAPACITOR: silver mica; 200-mmf ±2%; 500-vdcw; ASA CM20C201G; fixed; Dubilier 5R, Aerovox 1469.	1	*		*	*	*
320	3K2022143	I	CAPACITOR: silver mica; 220-mmf ±2%; 500-vdcw; ASA No. CM20D221G; fixed; Dubilier 5R, Aerovox 1469.	1	*		*	*	*
314	3K2027143	I	CAPACITOR: silver mica; 270-mmf ±2%; 500-vdcw; ASA No. CM20D271G, Dubilier 5R, Aerovox 1469.	1	*		*	*	*
324	3K2036143	I	CAPACITOR: silver mica; fixed; 360-mmf ±2%; 500-vdcw; ASA No. CM20D361G, Aerovox 1469, WE Co.	1	*		*	*	*
326	3K2039143	I	CAPACITOR: silver mica; 390-mmf; 500-vdcw; ±2%; ASA CM20D391G (fixed; molded bakelite; 51/64″ lgth x 15/32″ wide x 7/32″ thick, two 1-1/8″ lgth No. 20 AWG lead-alloy coated pigtail leads; ASA spec. C75.3-1942; characteristics D, 2%; micamold).	1	*		*	*	*
325	3K2043143	I	CAPACITOR: mica; 430-mmf ±2%; 500-vdcw; ASA type CM20D431G.	1	*		*	*	*
315-1 through 315-9	3K2047111	I	CAPACITOR: mica; 470-mmf ±10%; 500-vdcw; ASA No. CM20A471K, Dubilier 5W, Aerovox 1468.	9	*		*	*	*

414-1 through 414-16	3K2047124	I	CAPACITOR: mica; fixed; 470-mmf ±20%; 500-vdcw; ASA No. CM20B471M, Dubilier 5WL, Aerovox 1468L.	16	*		*	*	*
321-1 321-2	3K2051112	I	CAPACITOR: mica; 510-mmf ±5%; 500-vdcw; fixed; ASA No. CM20A511J, Dubilier 5W, Aerovox 1468.	2	*		*	*	*
316	3K3091143	I	CAPACITOR: silver mica; 910-mmf ±2%; 500-vdcw; fixed; ASA No. CM30D911G, Dubilier IR, Aerovox 1464.	1	*		*	*	*
317-1 317-2	3K3020243	I	CAPACITOR: silver mica; 2,000-mmf ±2%; 500-vdcw; fixed; ASA No. CM30D202G, Dubilier IR, Aerovox 1464.	2	*		*	*	*
311	3K3022224	I	CAPACITOR: mica; 2,200-mmf ±20%; 500-vdcw; fixed; ASA No. CM30B222M, Dubilier IWL, Aerovox 1467L.	1	*		*	*	*
318	3K3024243	I	CAPACITOR: silver mica; 2,400-mmf ±2%; 500-vdcw; ASA CM30D242G (fixed; molded bakelite case).	1	*		*	*	*
323	3K3030243	I	CAPACITOR: silver mica; 3,000-mmf ±2%; 500-vdcw; ASA CM30D302G (fixed; molded bakelite case).	1	*		*	*	*
334-1 334-2	3DA3-34	I	CAPACITOR: paper; 3,000-mmf WE Co 404B; 800-vdcw (fixed; ±20%; mineral-oil impregnated; −40° to +185° F ambient temperature).	2	*		*	*	*
327-1 through 327-6	3DA6-49	I	CAPACITOR: mineral-oil impregnated; molded paper dielectric; fixed; 0.006-mf ±20%; 600-vdcw at −40° F to 185° F; WE Co mfg No. 404A.	6	*		*	*	*
415	3K3568224	I	CAPACITOR: mica; fixed; 6,800-mmf ±20%; 300-vdcw; type ASA CM35B682M, Dubilier.	1	*		*	*	*
319	3K4010343	I	CAPACITOR: silver mica; 10,000-mmf ±2%; 300-vdcw; ASA No. CM40D103G (fixed; molded bakelite case).	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
322	3K6010321	I	CAPACITOR: mica; 10,000-mmf; 2,500-vdcw; ±10%; ASA CM60B103K (fixed; molded low-loss bakelite).	1	*		*	*	*
328	3DKA30-19	I	CAPACITOR: paper; 0.03-mf ±20%; 7,500-vdcw; 0.03 max to 0.027 min; type KS-8622, GE.	1	*		*	*	*
329	3DA50-78.3	I	CAPACITOR: paper; dual; 50,000-mmf; 600-vdcw; ±20%; Dubilier DYR-60055 (fixed; Dykanol - impregnated; hermetically sealed metal can).	1	*		*	*	*
313	3K2010133	I	CAPACITOR: 100-mmf; ±2%; mica; 500-vdcw; AWS C75.3; CM20C101G.	1	*		*	*	*
333	3DA100-116.2	I	CAPACITOR: paper; 0.1-mf +20% −10%; 600-vdcw; Solar XDMRTW6-0.1 (fixed; salt-water immersed; oil-impregnated; hermetically sealed metal can).	1	*		*	*	*
343-1 343-2	3DA100-192	I	CAPACITOR: paper; 0.1-mf +20% −10%; 600-vdcw; Solar XEMRB6-0.1 (fixed; mineral-oil filled; hermetically sealed metal can).	2	*		*	*	*
344-1 through 344-7	3DA100-196	I	CAPACITOR: fixed; paper; 0.1-mf +20% −10%; 600-vdcw; Solar XTIMOW6-0.1, salt-water immersed; mineral-oil impregnated; outer cardboard tube removed; 1-11/16″ long x 11/16″ diam over-all; two 2″ long axial wire leads.	7	*		*	*	*
330	3DA100-196.1	I	CAPACITOR: fixed; paper; 0.1-mf; 1,000-vdcw; +20% −10%; Solar XTIMOW10-.1; mineral-oil impregnated; outer cardboard tube removed; 2-1/16″ length x 11/16″ OD; two 2″ length axial wire leads.	1	*		*	*	*

342	3DA100-116.4	I	CAPACITOR: fixed; paper; 3-section; 100,000—100,000—100,000-mmf +20% −10%; 600-vdcw; Solar 3XDMRWT6-.1 (salt-water immersed; oil-impregnated; hermetically sealed).	1	*		*	*	*
331	3DA250-61	I	CAPACITOR: paper; 0.25-mf ±10%; 2,000-vdcw; Aerovox 2009MSB (fixed; moisture-resistant; oil-filled; hermetically sealed metal can, equipped with side clamps with right-angle projecting spade lugs for 3-1/8″ mounting centers).	1	*		*	*	*
336-1 336-2	3DKA250-67	I	CAPACITOR: paper; Dykanol-filled and impregnated; 250,000-mmf; 600-vdcw; +20% −10%; Dubilier DYR-6025 (fixed; metal can).	2	*		*	*	*
332	3DA500-104.3	I	CAPACITOR: fixed; paper; 0.5-mf +20% −10%; 1,000-vdcw; Dykanol "A" impregnated; rectangular metal case.	1	*		*	*	*
337	3DB1.6100B	I	CAPACITOR: paper; 1-mf; 600-vdcw; +20% −10%; fixed; Dykanol-filled and impregnated; hermetically sealed; Dubilier type DYR-6100.	1	*		*	*	*
338	3DB2.6200	I	CAPACITOR: paper; 2-mf; 600-vdcw; +20% −10%; Dubilier type DYR-6200-N.	1	*		*	*	*
339-1 339-2	3DB2.10020	I	CAPACITOR: 2-mf; 1,000-vdcw; ±10%; Dubilier type TJH-10020.	2	*		*	*	*
411	3D9003A3	I	CAPACITOR: ceramic; 3.3-mmf ±1 mmf; 500-vdcw; Erie type P120K.	1	*		*	*	*
310	3D9010-24	I	CAPACITOR: ceramic; 10-mmf ±1 mmf; 500-vdcw; Erie type NPOK-10.	1	*		*	*	*
341	3D9042V	I	CAPACITOR: variable; 5-42-mmf; WE Co type 357D.	1	*		*	*	*
308-1 through 308-4	3D9050-46.2	I	CAPACITOR: ceramic; 50-mmf ±2%; 500-vdcw; Erie No. P120M; fixed; positive temperature coefficient 0.000120-mmf/degree C.	4	*		*	*	*
412	3K2047024	I	CAPACITOR: fixed; mica; 47-mmf ±20%; 500-vdcw; ASA spec C75.3-1942, CM20B470M.	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
	2Z2639-16	M	CLAMP: cable; 0.025″ x 5/8″ wide; aluminum alloy; Tinnerman Products 3044-3.	1					*
	2Z2639-17	M	CLAMP: cable; 0.025″ x 5/8″ wide; aluminum alloy; Tinnerman Products 3044-4.	4					*
	2ZK2636-2	AD	CLAMP: cable; amphenol AN-3057-10; (die-cast aluminum; fits AN fitting size 10, 1-1/8″ lg x 1-3/16″ OD, 11/16″ ID, two No. 8-32 x 3/4″ screws).	1	*				*
	2Z2635.26	RF	CLAMP: WE Co ES-803947-3, (gray, lacquered, 0.050″ sheet steel; 3/8″ wide, 2-1/4″ over-all; semi-circular).	9	*				*
	2Z2636-28	I	CLAMP: tube; stainless steel; Birtcher 926-A; (consists of band 4-15/64″ lg x 3/8″ wide, with 1/8″ radius crimp in center).	2	*				*
	2Z2636-26	I	CLAMP: tube: stainless steel; Birtcher 926-C; (consists of band 4-7/8″ lg x 3/8″ wide, with 1/8″ radius crimp in center).	6	*				*
	2Z2724-9	I	CLIP: cathode-ray; Cinch Mfg Corp 8657 (over-all 3/4″ wide x 1-3/16″ lg embedded in rubber suction cut 3/4″ OD x 3/8″ high x 1/4″ diam).	1	*				*
	2Z2724	I	CLIP: cap; National 24 (brass; spring; action type crimps over lead for connections; 3/8″ diam closed, 1″ over-all lgth).	1	*				*
502	3H963	AD	CLUTCH: magnetic; KS-5860, List 1, Stearn.	1					*
707	3C387-1	I	COIL: deflection; 2-1/16″ x 2-1/2″ diam; inductance 0.055 to 0.045 henry; d-c resistance at 68° F, 0.025 ohms; ES-804128-1, WE.	1					*

708	3C580	I	COIL: focus; WE Co D-163194 [consists of 3 windings, d-c resistance of windings (1-2) 5,700-ohm, 19,300 turns No. 36 enameled wire; (3-4) 2,500-ohm, 2 coils, 7,560 turns No. 40 enameled wire; (5-6) 2,500-ohm, 2 coils, 7,560 turns No. 40 enameled wire; windings potted in and insulated from hermetically sealed metal case 29/32″ high x 3-1/2″ diam, six 3/4″ HT terminal pins mtd in case cover].	1					*
429-1 429-2	3C1987-70	I	COIL: retardation; fixed inductance (detector output inductance for reducing 60-megacycle current; WE Co D-161570).	2	*				*
367	3C303-19	I	COIL: choke; WE Co KS-8982 [winding (1-2) 38.5-ohm d-c resistance at 68° F; winding (1-2) 0.75-henry effective inductance with 20-volt ±0.4-volt, 800 ±40 cycle per section across winding and 0.400 ±0.008 ampere d-c in winding; unpotted; silicon steel core; moisture-resistant].	1	*				*
366-1 366-2	3C1084Q-3	I	COIL: retard; 20 turns BE wire wound on phenolic rod 3/4″ long x 3/16″ diam ES-804107-2, WE.	2	*				*
428-1 428-2 365	3CK1066-10	I	COIL: inductance; WE ES-690245-5; 90 turns No. 38 AWG enameled wire close-wound on 1/4″ diam hard-rubber rod 29/32″ lg, two No. 18 AWG wires inserted in side of form 1/8″ from end for connections.	3	*				*
435-1 435-2	3CK1066-19	I	COIL ASSEMBLY: r-f; WE Co ES-690245-8 (single close-wound winding, air core, 8-1/2 turns No. 30 wire wound on Bakelite coil form, 13/16″ lgth x 7/16″ diam shank on each end of form).	2	*				*
	2C3736-1/C2	RF	COIL ASSEMBLY: i-f; ES-824133-1, WE.	1	*				*
25-1 through 25-4	3C1084Q-3	RF	COIL: choke, r-f; ES-804107-2, WE; (20 turns No. 26 enameled wire wound on phenolic laminated rod 3/4″ lg x 3/16″ diam; two 0.041″ diam holes, 1/8″ from each end).	4	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
24	2C3736-1/C1	RF	COIL ASSEMBLY: choke; 4 windings; ES-824133-2, WE.	1	*				*
	2A990-14/C1	AD	CONDUCTOR ASSEMBLY: tubular; approx 49″ long with spacer pins; Western Electric Co ES-804819-2.	1					*
	2C3736-1/C3	RF	CONDUCTOR ASSEMBLY: inner, coaxial, steel; 6-1/2″ long x 5/8″ diam; ES-804156-1, WE.	1					*
	2Z3014-9	RF	CONDUCTOR: inner coaxial conductor ass'y; WE Co ES-804155-5; (tubular; brass; over-all dimen 5-17/32″ lg, 0.625″ diam; provided with plug in one end and inner capacity coupling in opposite end).	1					*
	2Z3193-7	RF	CONTACT: phosphor-bronze; tubular; WE Co ES-807758-1; (over-all dimen 13/32″ lg 0.219″ OD x 0.189″ ID, 8-0.015″ vertical saw slots).	1					*
	2C3736-1/C4	RF	CONTACT ASSEMBLY: 3/4″ x 1/2″ x 1-1/8″; contact shoe secured in bronze spring; ES-803916-1, WE Co.	4					*
	2C684-13		CONTROL UNIT C-13/TPS-1: Western Electric Co No. X-61705F.	1					*
	3E4036-14.1/2-1	I	CORD: 14-1/2″ lgth between outer ends of molded caps; WE Co D-164698 (shielded high-voltage cable No. 16 AWG stranded wire conductor; one end terminates in cathode-ray tube contact assembly; 2,000 volts a-c breakdown test).	1	*				*
	3E4036-16	RF	CORD: 16″ length of RMA or GE No. 16 microwave cable connected to ferrule-type terminal; WE Co dwg ES-827002-4; (consists of D-163476 jack and ES-804140-3 cap).	1					*

3E4036-4-1	RF	CORD: 4″ length of KS-8640 cordage, No. 16 AWG stranded wire; WE Co dwg ES-804140-1; (P68952 terminal punching at one end; BA-10061-1 banana plug at other end).	1	*			*	*
3E4036-3.1/2	RF	CORD: 3-1/2″ lgth; WE Co No. ES-804120-2; (consists of plug No. D-163446 connected to cable No. D-163-296).	1					*
2Z3273-2	RF	COUPLER: metal; 2-3/8″ x 1-1/4″; knurled; ES-804740-4, WE Co.	1					*
2A990-14/C2	AD	COUPLER: rotary, outer 48-1/2″ x 4-1/2″ diam; ES-825038-3, WE Co.	1					*
2Z3291-8	I	COUPLING: azimuth; WE ES-827131-5; (steel; rectangular; 5/8″ lg x 7/16″ diam; 1 end knurled, other end drilled 0.1875″).	1	*				*
2Z3290	I	COUPLING: flexible; Cardwell type A, RCA dwg No. K-850662-4; (max 1-1/4″ lgth for 1/4″ diam shaft insulation).	22	*				*
2Z3764.11	I	DIAL: 7″; azimuth; WE ES-827036-1; (amber plexiglas; 7-7/16″ OD, 6-1/16″ ID, 1/8″ thick; V-shaped notches, radius 45° from notches).	1	*				
2Z3764.10	I	DIAL: 7″; marking; WE ES-827036-2; (clear plexiglas; 7-7/16″ OD, 1/16″ thick, an inner circle 6-1/32″ diam, V-notches 1/8″ wide in outer rim 180° apart).	1	*				*
3G1839-19	RF	DISK: phenolic laminated; 0.806″ x 3/16″; ES-803935-1, WE Co.	1					*
2C3736-1/F1	RF	FILTER ASSEMBLY: anode; over-all length 3-17/32″ x 0.312″ diam; ES-803929-3, WE Co.	2					*
2C1565-12/F1	I	FILTER ASSEMBLY: anode; WE ES-804059-1; (cylindrical; over-all dimen 3-17/32″ lg x 0.312″ diam not including bracket protruding 3/8″; two 1,000-ohm, 1/2-watt, Allen-Bradley type EB resistors and two D-162582 resistors) part of oscillator.	1					*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	2A3346	MTP	FOOT ASSEMBLY: (stake); 7/8″ x 7/8″ x 4-1/8″; ES-804553-4, WE Co.	4				*	*
375	3Z1927	I	FUSE FU-27: (2-ampere, 250-volt; Littelfuse type 3-AG 1042; cartridge; glass body).	1	*		*	*	*
376	3Z1950	I	FUSE FU-50: (3-amp, 250-volt; Littelfuse type 3-AG 1043; glass body).	1	*		*	*	*
377	3Z2605.2	I	FUSE: 5-amp, 250-volt; type 3-AG 1358, Littelfuse.	1	*		*	*	*
378	3Z2608.1	I	FUSE: 8-amp, 250-volt; Littelfuse 3-AG 1360.	1	*		*	*	*
	2Z4866.34	M	GASKET: coprene; WE Co BO-30524-7; (flat, round; 1/4″ thk, 1-3/16″ OD, 5/16″ ID).	2					*
	2Z4866.32	AD	GASKET: gearbox; coprene; WE Co ES-824122; (irregular oval-shaped; over-all dimen 17-39/64″ lg, 6-1/2″ w, 1/16 thk, provided with 16 holes 0.281″ diam).	2					*
	2Z4866.68	AD	GASKET: lead; WE Co ES-824185-1; (flat, circular; 11/16″ OD x 13/32″ ID x 1/16″ thk).	4	*				*
	2Z4866.33	M	GASKET: coprene; WE Co ES-696745-2; (6-17/32″ ID, 7-11/32″ OD x 1/8″ thk).	1					*
	2Z4866.36	M	GASKET: coprene; WE Co BO-30408-4; (rectangular; 3-5/16″ x 2-1/4″ x 1/16″, one 0.375″ hole drilled in center, four 0.152″ holes drilled on 3″ x 1″ centers).	1					*
	2Z4866.37	M	GASKET: coprene; 2-13/16″ x 2-1/4″ x 1/16″; BO-30408-2, WE Co.	1					*
	2Z4866.35	M	GASKET: coprene; WE Co ES-694794-5; (1-1/16″ ID, 1-7/16″ OD, 1/16″ thk).	2					*
	2Z4870-25	AD	GEARBOX ASSEMBLY: ES-824116-2, WE Co.	1					*

	2C684-13/G1	C	GEARBOX ASSEMBLY: ES-804748-1, WE Co.	1					*
	6Z4914	M	GROMMET: rubber; American Radio Hardware 1114, Atlantic India Rubber 54G; (11/32″ OD, 1/8″ ID, 3/16″ thick, fits 1/4″ hole, 1/16″ groove; Hallicrafters 16A012).	1	*				*
	2A1359-20	AD	GUY ASSEMBLY: ES-804820-9, WE Co.	4					*
	3ZK3275.4	I	HOLDER: fuse; type 3AG, Bussman HKM (molded bakelite, one solder terminal on end one on side).	1	*				*
	2Z5040-1	I	HOLDER: contact spring assembly; WE ES-827052-1; (consists of arc-shaped phenolic holder 62° lg x 1-25/32″ wide x 3/16″ thick, two V-shaped assembly attached to brass block base 29/32″ lg x 9/16″ x 5/16″).	1	*				*
	2Z5040-360	I	HOOD M-360: Amphenol 83-1H; (3/4″ lg; cone-shaped; silver-plated; serves as receptacle shield; GE dwg No. K-7887470).	2					*
163	3H402-1/H10	M RF	HOUSING: for blower KS-5992 LO2, L-R Mfg.	2					*
	2C1556-16		INDICATOR UNIT ID-16/TPS-1A: (including tubes); Western Electric Co No. X-61705S; used with Radio Set AN/TPS-1A.	1					*
	3G1550-12	RF	INSULATOR: mica; WE Co ES-803935-2; (0.760″ lg, 0.260″ wide, 0.005″ thk, ends rounded on 0.130″ radius, 0.093″ hole drilled on horizontal center line 0.130″ from end).	1	*				*
	3G1838-29.2	M	INSULATOR: natural color bakelite; WE Co 696388-8; (1-13/16″ lg, 3/8″ wide, 1/16″ thk, two 0.180″ holes spaced 1-1/2″ between centers; wax impregnated).	1	*				*
	3G1500-27	RF	INSULATOR: spacer; glass bonded mica; WE Co ES-804205-3; (rectangular; 1.671 x 0.627 x 1/16″ thk).	1	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	3G1250-20.6	I	INSULATOR: ceramic; round post; American Lava 1708 (1-1/4″ lg over-all, 3/8″ diam each end drilled and tapped No. 6-32).	3	*				*
396-1 through 396-5	2Z5581-12	I	JACK: 78-1P-black Amphenol.	5	*				*
372-1 372-2	2Z5575-9	I	JACK: coaxial; single-contact; WE Co D-163474; (cylindrical; 5/8″ OD x 1-25/32″ over-all; equipped with wall mtg plate 1″ x 0.0800″ having four 0.125″ holes, 0.719″ between centers).	2	*				*
	2Z5575-11	RF	JACK ASSEMBLY: ES-804073-1, WE.	4	*				*
	2Z5575-8	RF	JACK: coaxial type; WE Co D-163476; (cylindrical; brass; 1″ OD x 1-25/32″ lg, single cont; insulated; consists of a shell with a 0.397″ ID cable entrance attached to jack body).	1	*				*
	6L995-2	AD	KEY: Woodruff No. 2; (Caterpillar Tractor special 1B8701; 3/32″ x 1/2″; SAE 2330 or equiv).	2					*
	2Z5789-3	RF	KNOB: C.D.S.; 3/8″ diam, 5/16″ long; knurled; ES-803927-3, WE Co.	2					*
	2Z5748.21	I	KNOB: Croplastic; 7/8″ diam x 19/32″, shaft diam 1/4″; 6129 Crowe.	6					*
	2Z5822-2	I	KNOB: molded phenolic; Kurz-Kasch S-246-3L, Crosley W-211548-2; (brass bushing for 1/4″ shaft, white filled pointer type, 1-1/2″ lg x 7/8″ wide x 7/8″ high; Philco No. 257-6013).	2	*				*
397-1 397-2 397-3 397-4	2Z5952	I	LAMP LM-52: pilot; Mazda 47 or equal; size T 3-1/4″ (6-8-volt 0.15-amp; minature bayonet base; Brown Bead).	4	*		*	*	*

	6Q63141	AD	LEVEL: spirit; machinist's; iron, nickel-plated; 4″ long; Stanley 38-1/2″.	1					*
	2C1565-12/C4	I	LOOP ASSEMBLY: output coupling; part of oscillator ES-803930-2, WE.	1					*
	2C684-13/M1	C	MAGNET ASSEMBLY: WE Co D-164280; (consists of steel base between sub-base of permendur and two horn magnets connected by removable magnet shunt).	1					*
	2C2507	RF	MODULATOR ASSEMBLY: less tubes; ES-803910; Western Electric Co.	1					*
	2C2537-2		MODULATOR UNIT MD-2/TPS-1: (including tubes); Western Electric Co No. X-61705H.	1					*
500	3H3100A16-2	AD	MOTOR: shunt wound; 1/6-hp; 27v, 1,750 rpm; KS-5854, list 01, WE Co.	1	*				*
164 14	3H3000-30	M RF	MOTOR: blower; 400-cycle permanent split phase capacitor; 1/100-hp; 115v, 7,200 rpm; Western Electric Co dwg KS-5991, LO1.	2	*				*
700	3H3000-30	I	MOTOR: blower; 400-cycle permanent split phase capacitor; 1/100-hp, 115v, 7,200 rpm; Western Electric Co dwg No. KS-5991, LO1.	1	*				*
	2Z8402-1	I	MOUNT: shock; rubber; 1″ diam x 13/32″ mtd on diamond-shaped steel plate; type 100 PD-4.	4					*
	2Z8405-4	RF	MOUNT: shock; rubber; over-all 3″ x 3″ x 1-1/2″; No. 200 PH15, Lord.	2					*
	2Z8498	RF	MOUNT: shock; rubber; over-all 3″ x 3″ x 1-1/2″, connector 4-3/4″ x 5/32″ riveted to mounting; ES-804122-6, WE Co.	2					*
	2Z8498-1	M	MOUNT: shock; rubber; over-all 2-3/8″ x 2-3/8″ x 1-1/16″, connector 4-3/4″ x 5/32″ riveted to mounting; ES-804122-1, WE Co.	5					*
115	2C2537-2/N1	M	NETWORK: metal containers; over-all 2-9/32″ x 3-11/32″ x 4-11/16″; D-166871, WE Co.	1				*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock 1st ech	Orgn stock 2d ech	3d ech	4th ech	Depot stock
	6L3604-40.3	M RF AD ACC	NUT: steel; hex; No. 4-40 thd, 3/32″ thk, 1/4″ across flats; Steel Co of Canada (cadmium-plated).	125	*				*
	6L3606-32.3	M RF AD ACC	NUT: hex; steel; No. 6 (0.138)-32.	72	*				*
	6L3608-32.3	M C RF AD ACC	NUT: hex; steel; No. 8 (0.164)-32.	46	*				*
	6L3610-32.3	M AD ACC	NUT: iron; hex; No. 10-32; zinc-plate, chromate finish.	22	*				*
	6L3504-20.10C	M RF AD	NUT: hex; steel; 1/4″ (0.250)-20.	17	*				*
	6L3806-20S	AD	NUT: wing; steel; 1/4″ (0.250)-20.	1					*
	6G1394.1	M	OIL: transil; WE Co, grade 10C; (impregnating oil, 1-qt containers).	2					*
	2C2537-2/01	M	OIL UNIT: metal assembly; 11-5/8″ x 10″ x 14-7/8″ over-all; D-151354, WE Co.	1	*				*
703	2C1565-12/01	I	OSCILLATOR ASSEMBLY: WE ES-803912-1; (metal; cylindrical; over-all approx 7-1/2″ x 1-1/2″ diam).	1					*

	2C2507/01	RF	OUTPUT ASSEMBLY: modulator; WE Co ESR-803915-1; (metal; cylindrical; approx 5″ lg with varying diameters, max 1-1/4″ OD, consists of an i-f coil assembly, ES-824133-1 encased in one end of tube, ES-803916-3, capacitor insulator, ES-803935-2).	1					*
399	3Z6993	I	PAD ASSEMBLY: silver-plated brass; 2-7/16″ x 11/16″ diam; BO-410156-4 (4db).	1					*
	2Z7067.7	C	PIN ASSEMBLY: steel; WE Co ES-804550-9; (over-all lgth approx 9-17/32″; consists of 3/8″ diam x 2-5/8″ lg steel pin with ring at one end to which is attached steel chain 6″ lg).	1					*
	2A990-14/P1	AD	PIN ASSEMBLY: WE Co ES-824121-2; (consists of steel pin and ring at one end to which is attached a No. 8A steel chain, 9-3/4″ lg overall).	1					*
441	2ZK7118.2T	I	PLUG: 8-prong; octal; Amphenol CP-8T; (mica-filled bakelite; 1-9/32″ diam x 1″ long, mtg hole 1.172″ diam; cadmium-plated phosphor-bronze contacts).	1	*				*
370	2ZK7104-6	I	PLUG: coaxial; cylindrical type; single-contact; WE Co. D-164458.	1	*				*
368	2Z7111.51	I	PLUG: coupling type; cylindrical; H.B. Jones P101-1/4; (single brass tubular pin cont. 1/8″ lg x 11/16″ diam with a 9/16″-18 top).	1	*				*
156-1 to 156-8 inc.	2Z7111.50	M	PLUG: 1-contact; brass; General Radio 274P with silver-plate finish; (single mtd, not insulated).	8	*				*
	2Z7112.18	M	PLUG: aluminum alloy; 1-1/2″ diam x 11/16″ threaded; ES-694794-3, WE.	2	*				*
	2C3736-1/T4	RF	PLUG ASSEMBLY: tuning; ES-804152-5, WE.	2	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	2Z7111.52	RF	PLUG: banana type; 1-contact; American Radio 131; (brass, nickel-plated; 1-5/8″ lg with insulated sleeve 7/8″ lg x 0.170″ ID with setscrew inside to secure connecting wire; per WE dwg No. BA-10061-1).	2	*				*
	2Z7111.54	RF	PLUG: coaxial; 1-contact; WE D-163446; (brass; cylindrical type; 1-21/32″ x 3/4″ diam; insulated body 0.29/32″ x 0.570″ diam connected to shell).	4	*				*
	2Z7111.55	RF	PLUG: coaxial; D-163472, WE.	1	*				*
	2Z7110-4	AD	PLUG: rectangular; steel; ES-824189-1, WE.	1	*				*
	2C1565-12/P1	I	PLUNGER: phosphor-bronze; WE ES-803917-5; (hollow; cylindrical; 0.881″ ID x 1.238″ OD x 7/8″ lg).	1					*
	2C3736-1/P1	RF	PLUNGER: phosphor-bronze; 1.238″ OD x 0.881″ ID x 7/8″ lg; ES-803917-3, WE Co.	3					*
	2C1565-12/P2	I	PLUNGER ASSEMBLY: silver-plated, phosphor-bronze plunger with nickel-silver guide; ES-803925-1, WE.	1					*
	2Z7255-26	RF	PLUNGER ASSEMBLY: metal; 2-3/4″ lg; part of amplifier assembly; ES-803911, WE Co.	2					*
	2C3736-1/P2	RF	PLUNGER ASSEMBLY: part of modulator assembly; ES-803910, WE Co.	1					*
	2C1565-12/P2	RF	PLUNGER ASSEMBLY: WE Co ES-803925-1; (consists of phosphor - bronze silver - plated plunger and nickel-silver guide, guide is cylindrical 0.188″ OD x 0.126″ ID x 3-15/32″ lg, external thread at one end 0.190″-48 x 13/64″, plunger is cylindrical 0.8065″ OD x 0.314″ ID).	2					*

42-1 42-2	2Z7268.11	RF	POTENTIOMETER: 600-ohm; WE Co ES-691122-57 (Allen-Bradley type J; carbon; 2-watt; ±20%; metal case 1-1/6″ diam x 9/16″ lg, shaft 1/4″ diam extends 1/8″ beyond bushing; 3 terminals).	2	*				*
43	2Z7268.12	RF	POTENTIOMETER: 1,500-ohm; WE Co ES-691122-56; (Allen-Bradley type J; carbon; 2-watt; ±20%; metal case 1-1/16″ diam x 9/16″ lg, shaft 1/4″ diam extends 1/8″ beyond bushing; 3 solder terminals).	1	*				*
137	2Z7271-12	M	POTENTIOMETER: 100,000-ohm; Allen-Bradley type J; (composition; 2-watt; ±10%; round metal case 1-1/16″ diam x 9/16″ lg; 3 projecting terminals; shaft, screwdriver type, 1/4″ diam extending 1/8″ beyond bushing, equipped with shaft locking arrangement).	1	*				*
299	2Z7280-42	I	POTENTIOMETER: 4,000-ohm; Mallory M4MP; (wirewound; 4-watt; metal case 5/8″ diam x 9/16″ deep, shaft 0.248″ diam extending 13/32″ beyond end of bushing, 3 projecting terminals each 3/8″ lg).	1	*				*
288-1 288-2	2Z7269.62	I	POTENTIOMETER: 5,000-ohm BTL 10034-176, Allen-Bradley type J; (carbon; 2-watt; metal case 1-1/16″ diam x 9/16″ deep, shaft 1/4″ diam x 15/16″ beyond bushing).	2	*				*
303	2Z7280-18	I	POTENTIOMETER: 10,000-ohm; Ohmite J 0332; (wirewound; 50-watt; ±20%; shaft 1/4″ diam projects 1/2″ beyond bushing).	1	*				*
290	2Z7271-38	I	POTENTIOMETER: 75,000-ohm; 2-watt; Allen-Bradley type J, BTL 10034-177; (carbon; round metal case; shaft diam 1/4″ x 1″ beyond bushing).	1	*				*
291-1 292-2	2Z7273-25	I	POTENTIOMETER: 100,000-ohm ±20%; type J, Allen-Bradley.	2	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
292-1 292-2 293-3	2Z7271-37	I	POTENTIOMETER: 0.1-megohm; Allen-Bradley type J, WE Co ES-696040-8; (carbon; 2-watt; round metal case 1-1/16″ diam x 9/16″ deep, shaft 0.250″ diam extending 1/4″ beyond end of bushing).	3	*				*
293	2Z7271-39	I	POTENTIOMETER: 0.2-megohm; Allen-Bradley type J, BTL 10034-250; (carbon; 2-watt; round metal case 1-1/16″ x 9/16″, shaft 1/4″ diam x 1-7/8″ beyond bushing).	1	*				*
285	2Z7267.8	I	POTENTIOMETER: 200 - ohm; Allen - Bradley type J, BTL 10034-297; (carbon; 2-watt; round metal case 1-1/16″ diam x 9/16″, shaft 1/4″ diam x 1/4″).	1	*				*
286-1 286-2	2Z7268.24	I	POTENTIOMETER: 2,000-ohm; Allen-Bradley type J, BTL 10034-247; (carbon; 2-watt; round metal case 1-1/16″ diam x 9/16″ long, shaft 1/4″ diam x 3/4″ beyond bushing).	2	*				*
287	2Z7269.39	I	POTENTIOMETER: 4,000-ohm; Allen-Bradley type J, BTL 10034-249; (carbon; 2-watt; round metal case 1-1/16″ diam x 9/16″, shaft 1/4″ diam x 1/4″ beyond bushing).	1	*				*
295	2Z7273-26	I	POTENTIOMETER: 1.0-megohm ±20%; Allen-Bradley type J, BTL 10034-254; (carbon; 2-watt; round metal case, 1-1/16″ x 9/16″, shaft 1/4″ diam x 1/4″).	1	*				*
294-1 294-2	2Z7273-27	I	POTENTIOMETER: 1.0-megohm ±20%; Allen-Bradley type J, BTL 10034-254; (carbon; 2-watt; round metal case 1-1/16″ x 9/16″, shaft 1/4″ diam x 3/4″).	2	*				*
	3Z12500-1.3	I	PUNCHING: terminal assembly; L-shaped; 5/32″ long, with bushing; P-371198, WE.		*				*

	2C3736-1		RADIO - FREQUENCY UNIT, RF-1/TPS-1: Western Electric Co No. X-61705E.	1					*
379	6Z7813-3.1	I	RECEPTACLE: 2-wire; flush base; midget; female; Hubbell Twistlock 7468, CR-11616 (10-amp 250-v, 15-amp 115-v; Belmont dwg No. A-55A-1288).	1	*				*
151	2Z7589-9	M	RELAY: DPST; Leach Relay Co No. 1025-SNBF, Western Electric Co ES-682944-1.	1	*				*
506	2Z7586-35	AD	RELAY: Western Electric Co KS-5814, LO1.	1	*				*
386	2Z7586-35	I	RELAY: SPST; type KS-5814, LO1, Western Electric Co.	1					*
387	2Z7589-23	I	RELAY: DPDT; Allied Control KS-5910, List 04; (25-v, d-c adjusted to operate on 18-v, single operating coil of 230 ohms, with iron core and magnetic yoke).	1					*
507	3Z4800A7	AD	RESISTOR: 7-ohm; 2,200-watt; ±10%; diam 8-1/2″; (Ribflex WL type, metal alloy resistance).	1	*		*	*	*
103-1 103-2	3Z6001-66	M	RESISTOR: 10-ohm ±10%; 10-watt; WW; 10NI, Sprague.	2	*		*	*	*
129	3Z6001H8-2	M	RESISTOR: 18-ohm; 1-watt; ±5%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280″.	1	*		*	*	*
101-1 101-2	3Z6002B2-9	M	RESISTOR: 22-ohm; 1-watt; ±20%; max lgth 1.28″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.310″.	2	*		*	*	*
66-1 66-2 66-3	3Z6004A7-8	RF	RESISTOR: 47-ohm; 1/2-watt; tubular shape; IRC BW-1/2; (fixed; ±10%; WW; 2 leads).	3	*		*	*	*
100-1 through 100-7 incl.	3Z6004A7-6	M	RESISTOR: 47-ohm; 1-watt; ±20%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280″.	7	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
44-1 44-2 44-3	3Z6010-36	RF	RESISTOR: 100-ohm; 1/2-watt; ±10%; max lgth 0.468", ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249".	3	*		*	*	*
131	3Z6010-88	M	RESISTOR: 100-ohm; 1-watt; ±20%; max lgth 0.718"; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280".	1	*		*	*	*
127-1 127-2	3Z6047-16	M	RESISTOR: 470-ohm; 1-watt; ±20%; max lgth 0.718"; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280".	2	*		*	*	*
49	3Z6050-83	RF	RESISTOR: 500-ohm; 50-watt; ±10%; fixed; WW; 4" long x 9/16" OD; Ohmite No. 2009; dual wound.	1	*		*	*	*
123	3Z6075-33	M	RESISTOR: 750-ohm; 1-watt; ±5%; max lgth 0.718"; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280".	1	*		*	*	*
65-1 through 65-5 incl.	3RC20BE102M	RF	RESISTOR: 1,000-ohm; 1/2-watt; ±20%; max lgth 0.468", ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249".	5	*		*	*	*
48	3Z6100-121	RF	RESISTOR: 1,000-ohm; 1-watt; ±20%; max lgth 0.718"; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280".	1	*		*	*	*
45	3Z6100-39	RF	RESISTOR: 1,000-ohm; 2-watt; ±10%; max lgth 1.78"; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.342".	1	*		*	*	*
130	3Z6180-2	M	RESISTOR: 1,800-ohm; 1-watt; +5%; International MW3; ref 13-7 of BD-100.	1	*		*	*	*

102	3Z6200-78	M	RESISTOR: 2,000-ohm; 4-watt; ±5%; (International AB; fixed; power type; WW; ceramic base 5/16″ diam x 1-3/4″ long; moisture-resistant).	1	*		*	*	*
46-1 46-2	3Z6506-13	RF	RESISTOR: 5,600-ohm; 1-watt; ±20%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; axial wire leads; max diam 0.280″.	2	*		*	*	*
135	3Z6610-58	M	RESISTOR: 10,000-ohm; 1-watt; ±5%; Allen-Bradley type GB, No. 1035.	1	*		*	*	*
122	3Z6610-59	M	RESISTOR: 10,000-ohm; 1-watt; ±10%; Allen-Bradley BGB; carbon; bakelite insulated; Stromberg-Carlson No. 30417.	1	*		*	*	*
149-1 149-2	3Z6610-153	M	RESISTOR: 10,000-ohm; 8-watt; ±10%; WW; (No. 3 terms "C" coating, International Resistance Co).	2	*		*	*	*
47	3RC41BE123K	RF	RESISTOR: 12,000-ohm; 2-watt; ±10%; International BT-2; fixed; metallized, ceramic or glass; 1-3/4″ lgth x 5/16″ diam; 2 axial leads.	1	*		*	*	*
138-1 138-2	3Z6636-4	M	RESISTOR: 36,000-ohm; 2-watt; ±5%; max lgth 1-3/4″ x 5/16″ diam; insulated, moisture-resistant.	2	*		*	*	*
139-1 139-2	3Z6656-16	M	RESISTOR: 56,000-ohm; 1-watt; ±5%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; axial wire leads.	2	*		*	*	*
136	3Z6715-20	M	RESISTOR: 150,000-ohm; 1-watt; ±5%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; axial wire leads.	1	*		*	*	*
134	3Z6727-4	M	RESISTOR: 270,000-ohm; 1-watt; ±5%; max lgth 1.28″; ASA C75.7-1943; fixed; composition.	1	*		*	*	*
132	3Z6730-9	M	RESISTOR: 300,000-ohm; 1-watt; ±5%; max lgth 1.28″; ASA C75.7-1943; fixed; composition; insulated; axial wire leads.	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
133-1 through 133-4 incl.	3RC20BE105J	M	RESISTOR: 1-megohm; 1/2-watt; ±5%; max lgth 0.468″, ASA C75.7-1943; fixed; composition; insulated; axial wire leads.	4	*		*	*	*
128	3Z6802A7-1	M	RESISTOR: 2.7-megohm; 1/2-watt; ±10%; max lgth 0.655″; ASA C75.7-1943; fixed; composition; insulated; axial wire leads.	1	*		*	*	*
200-1 through 200-3	3RC21BF470K	I	RESISTOR: 47-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	3	*		*	*	*
275	3Z6004A7-8	I	RESISTOR: 47-ohm; 1/2-watt; tubular shape; IRC BW-1/2; fixed; ±10%; WW; body dimen approx 3/16″; OD approx 5/8″ lg; 2 leads min.	1	*		*	*	*
260-1 through 260-3	3RC30BF470K	I	RESISTOR: carbon; 47-ohm, ±10%; 1-watt; Allen-Bradley type GB.	3	*		*	*	*
201	3RC21BF101K	I	RESISTOR: 100-ohm; 1/2-watt; ±10%; max lgth 0.468″; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
218	3RC21BF121K	I	RESISTOR: 120-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
261	3RC30BF151K	I	RESISTOR: carbon; 150-ohm ±10%; 1-watt; Allen-Bradley type GB.	1	*		*	*	*
401-1 through 401-4	3RC20BF221K	I	RESISTOR: 220-ohm; 1/2-watt; ±10%; max lgth 0.468″, ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	4	*		*	*	*

202	3RC21BF391J	I	RESISTOR: 390-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
203-1 through 203-4	3RC21BF471K	I	RESISTOR: carbon; 470-ohm ±10%; 1/2-watt; Allen-Bradley type EB.	9	*		*	*	*
402-1 through 402-5	3RC20BF471K	I	RESISTOR: 470-ohm ±10%; 1/2-watt; Allen-Bradley type EB.	5	*		*	*	*
246-1 246-2	3RC21BF102K	I	RESISTOR: 1,000-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	2	*		*	*	*
271	3Z6270-9	I	RESISTOR: 2,700-ohm; 55-watt; ±10%; fixed; flat type; WW; vitreous coating; 3-1/2″ lg x 1″ w x 3/8″ thick, solder terminals near end perpendicular to axis, mtg centers 4-1/4″; Hardwick, Hindle.	1	*		*	*	*
273	3Z6575-48	I	RESISTOR: 7,500-ohm; 55-watt; ±20%; max lgth 3-1/2″ x 9/16″ x 1″ deep; steatite core, embedded in vitreous enamel; flat type; 4-1/4″ mtg center with holes 3/16″ diam; lug terminals.	1	*		*	*	*
213-1 213-2	3Z6610-10	I	RESISTOR: 10,000-ohm; 1/2-watt; ±5%; max lgth 3/8″; diam 9/16″; insulated; Fairchilds dwg F62B-103-5.	2	*		*	*	*
403 208-1 through 208-4	3RC21BF103K	I	RESISTOR: 10,000-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	5	*		*	*	*
277-1 277-2	3Z6610-16	I	RESISTOR: 10,000-ohm; 2-watt; ±10%; max lgth 1-3/4″, diam 5/16″; insulated; International No. BT-2; fixed; composition.	2	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock 1st ech	Orgn stock 2d ech	3d ech	4th ech	Depot stock
209	3Z6612-8	I	RESISTOR: 12,000-ohm; 1/2-watt; ±10%; insulated; Allen-Bradley EB, WE Co dwg ESO-690364-38.	1	*		*	*	*
404-1 through 404-4 210-1 210-2	3RC21BF153K	I	RESISTOR: 15,000-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	6	*		*	*	*
211-1 211-2	3RC21BF183J	I	RESISTOR: 18,000-ohm; 1/2-watt; ±5%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	2	*		*	*	*
212	3RC21BF183J	I	RESISTOR: 18,000-ohm; 1/2-watt; ±5%; max lgth 0.655″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
268-1 through 268-4	3RC30BF203J	I	RESISTOR: 20,000-ohm; 1-watt; ±5%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280″.	4	*		*	*	*
248	3Z6622-10	I	RESISTOR: carbon; 22,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	1	*		*	*	*
263	3RC30BF223J	I	RESISTOR: 22,000-ohm; 1-watt; ±5%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280″.	1	*		*	*	*
204-1 through 204-4	3RC21BF222K	I	RESISTOR: 2,200-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	4	*		*	*	*
282	3Z5425.6	I	RESISTOR: 2,500-ohm; 10-watt; ±10%; fixed; wirewound; vitreous enameled; 5/16″ OD x 1-3/4″ lg, terminal 3/16″ x 9/16″ lg near end, perpendicular to the axis; Ward Leonard.	1	*		*	*	*

219	3RC20BE272K	I	RESISTOR: 2,700-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
205	3RC21BF332K	I	RESISTOR: 3,300-ohm; 1/2-watt; ±10%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
247	3RC20BE392J	I	RESISTOR: 3,900-ohm; 1/2-watt; ±5%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
272	3Z6400-52	I	RESISTOR: 4,000-ohm; 40-watt; ±20%; fixed; flat type; WW;vitreous coating; 2″ lg x 1″ w x 3/8″ thk, solder terminals near end, perpendicular to axis, mtg center 2-3/4″; Hardwick, Hindle.	1	*		*	*	*
206	3RC21BF472J	I	RESISTOR: 4,700-ohm; 1/2-watt; ±5%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
262	3RC30BF472M	I	RESISTOR: 4,700-ohm; 1-watt; ±20%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280″.	1	*		*	*	*
207	3RC21BF562J	I	RESISTOR: 5,600-ohm; 1-watt; ±5%; max lgth 1.28″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.310″.	1	*		*	*	*
276	3Z6568-18	I	RESISTOR: 6,800-ohm; 2-watt; ±10%; max lgth 1-3/4″, 5/16″ diam; fixed; composition; insulated; leads 1-1/2″ No. 19 wire; International BT-2, Philco No. 353-1083.	1	*		*	*	*
264	3RC30BF223K	I	RESISTOR: 22,000-ohm; 1-watt; ±10%; max lgth 0.718″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.280″.	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
278	3Z6622-22	I	RESISTOR: metallized; 22,000-ohm ±5%; 2-watt; BT-2, IRC.	1	*		*	*	*
214	3RC21BF273J	I	RESISTOR: 27,000-ohm; 1/2-watt; ±5%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	1	*		*	*	*
215-1 through 215-3	3RC21BF333J	I	RESISTOR: 33,000-ohm; 1/2-watt; ±5%; max lgth 0.468″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.249″.	3	*		*	*	*
283-1 through 283-4	3Z6639-5	I	RESISTOR: 39,000-ohm; 2-watt; ±10%; max lgth 1.78″; ASA C75.7-1943; fixed; composition; insulated; leads axial wire; max diam 0.342″.	4	*		*	*	*
216-1 through 216-3	3Z6647-2	I	RESISTOR: carbon; 47,000-ohm ±5%; 1/2-watt; EB, Allen-Bradley.	3	*		*	*	*
217-1 217-2	3Z6647-5	I	RESISTOR: 47,000-ohm; 1/2-watt; ±10%; fixed; insulated; Stromberg-Carlson No. 28177, Galvin No. 6B6323.	2	*		*	*	*
265-1 through 265-3	3RC30BF473K	I	RESISTOR: 47,000-ohm; 1-watt; ±10%; lgth 9/16″, diam 7/32″; fixed; carbon; No. 18 tinned wire leads 1-1/2″ lg.	3	*		*	*	*
266-1 through 266-4	3RC30BF563J	I	RESISTOR: 56,000-ohm; 1-watt; ±5%; fixed; 7/32″ diam x 9/16″ lg; axial wire leads, 1-1/2″; insulated.	4	*		*	*	*
220-1 through 220-4	3RC21BF683J	I	RESISTOR: 68,000-ohm; 1/2-watt; ±5%; fixed; lgth 9/16″, diam 3/8″; axial wire leads 1-1/2″ lg; Allen-Bradley; insulated.	4	*		*	*	*
221-1 221-2	3RC21BF823J	I	RESISTOR: 82,000-ohm; 1/2-watt; ±5%; fixed; insulated; 9/64″ diam x 3/8″ lg; axial wire leads; Allen-Bradley.	2	*		*	*	*

222	3RC20BE184J	I	RESISTOR: 180,000 - ohm; 1/2 - watt; ±5%; fixed; insulated; 3/8″ lg, 9/64″ diam; Fairchild dwg F62B-104-5, Allen-Bradley type C.	1	*		*	*	*
223-1 223-2	3RC20BE104K	I	RESISTOR: carbon; 100,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	2	*		*	*	*
267-1 267-2	3RC30BF104J	I	RESISTOR: 100,000-ohm; 1-watt; Allen-Bradley type GB No. 1045; ±5%; ASA spec RC30BE104J; fixed.	2	*		*	*	*
224	3RC21BF124J	I	RESISTOR: 120,000-ohm; 1/2-watt; International BT-1/2; ±5%; fixed; carbon; insulated; 5/8″ lg, 3/16″ diam; 1-1/2″ axial leads.	1	*		*	*	*
225-1 225-2	3RC21BF124K	I	RESISTOR: carbon; 120,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	2	*		*	*	*
226-1 226-2	3RC21BF154K	I	RESISTOR: carbon; 150,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	2	*		*	*	*
227-1 through 227-3	3RC21BF184K	I	RESISTOR: carbon; 180,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	3	*		*	*	*
228	3RC21BF224J	I	RESISTOR: 220,000-ohm; 1/2-watt; Allen-Bradley EB; ±5%; 3/8″ lg x 9/64″ diam, RCA 14583, dwg No. 2283-215.	1	*		*	*	*
269-1 269-2	3RC30BE224J	I	RESISTOR: carbon; 220,000-ohm ±5%; 1-watt; GB, Allen-Bradley.	2	*		*	*	*
229-1 229-2	3RC20BE224M	I	RESISTOR: 220,000-ohm; 1/2-watt; ±20%; Allen-Bradley. type EB, No. 2242; carbon; bakelite insulation; 3/8″ lg, 9/64″ diam; No. 20 tinned copper leads 1-1/2″ lg; Belmont Radio Corp. dwg A-9B1-27.	2	*		*	*	*
230-1 through 230-4	3Z6727-8	I	RESISTOR: carbon; 270,000-ohm ±5%; 1/2-watt; EB, Allen-Bradley.	4	*		*	*	*
231	3Z6727-9	I	RESISTOR: carbon; 270,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	1	*		*	*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
232-1 through 232-3	3RC20BE334K	I	RESISTOR: carbon; 330,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	3	*		*	*	*
233-1 through 233-6	3RC21BF334M	I	RESISTOR: carbon; 330,000-ohm ±20%; 1/2-watt; EB, Allen-Bradley.	6	*		*	*	*
234	3RC30BE394K	I	RESISTOR: 390,000-ohm; 1-watt; Allen-Bradley GB-3941; ±10%; fixed; carbon; insulated; 9/16″ lg, 7/32″ diam; No. 18 axial wire leads 1-1/2″ long.	1	*		*	*	*
235-1 through 235-4	3RC21BF474K	I	RESISTOR: 470,000-ohm; 1/2-watt; Allen-Bradley EB, or Speer S1-1/2; ±10%; fixed; carbon.	4	*		*	*	*
270-1 270-2	3RC30BE474K	I	RESISTOR: carbon; 470,000-ohm ±10%; 1 watt; GB, Allen-Bradley.	2	*		*	*	*
236-1 236-2	3RC21BF564K	I	RESISTOR: carbon; 560,000-ohm ±10%; 1/2-watt; EB, Allen-Bradley.	2	*		*	*	*
237	3RC21BF105K	I	RESISTOR: carbon; 1-megohm ±10%; 1/2-watt; EB, Allen-Bradley.	1	*		*	*	*
238	3RC20BE125J	I	RESISTOR: 1.2-megohm; 1/2-watt; Allen-Bradley EB, 1255; ±5%; fixed; carbon; insulated; 3/8″ long x 9/64″; axial leads.	1	*		*	*	*
280	3Z6802-29	I	RESISTOR: 2-megohm; 4-watt; International MVG; ±15%; metallized; wound on ceramic base 2″ lg x 9/16″ diam.	1	*		*	*	*
240-1 through 240-3	3RC21BF225J	I	RESISTOR: 2.2-megohm; 1-watt; Erie 505; ±5%; carbon; insulated; 11/16″ long, 1/4″ diam; Bendix dwg A18004-225, ASA type RC31AE225J.	3	*		*	*	*

241-1 241-2	3RC21BF225M	I	RESISTOR: 2.2-megohm; 1/2-watt; ±20%; lgth 0.468″; fixed; insulated; axial wire leads; 0.249″ diam; ASA type RC20BE225M, Allen-Bradley EB.	2	*		*	*	*
242-1 242-2	3RC20BE275J	I	RESISTOR: 2.7-megohm; 1/2-watt; ±5%; lgth 0.468″; fixed; insulated; axial wire leads; 0.249″ diam; ASA type RC20BE275J, Allen-Bradley EB.	2	*		*	*	*
243	3RC21BF335J	I	RESISTOR: 3.3-megohm; 1/2-watt; Erie 504; ±5%; fixed; carbon; ceramic insulation; 9/16″ lg x 0.225″ diam; axial wire leads 1-1/2″ long.	1	*		*	*	*
244	3RC21BF335M	I	RESISTOR: 3.3-megohm; 1/2-watt; Allen-Bradley EB-1/2; ±20%; fixed; molded bakelite; cylindrical; 9/64″ diam x 3/8″ long; axial wire leads 1-1/2″ long at each end.	1	*		*	*	*
245	3RC21BF475K	I	RESISTOR: carbon; 4.7-megohm ±10%; 1/2-watt; EB, Allen-Bradley.	1	*		*	*	*
279	3Z6805-21	I	RESISTOR: 5-megohm; 10-watt; wound on ceramic base 3/4″ OD x 4-1/2″ long; ±15%; metallized.	1	*		*	*	*
	3Z6961-8	M	RESISTOR MOUNTING ASSEMBLY: WE Co ES-692582-1; (two 10-ohm ±10% Sprague Koolohm resistors, mtd in bracket, phenolic plate 1-13/16″ x 1-1/4″ x 1/16″ thk, attached to bracket and two bent springs projecting 1-3/16″ from end of plate).	1					*
	2Z1026-2.1	RF	RETAINER: Tit type; fuse clip 0-30, 250-v H. B. Sherman.	2					*
	3Z1026-3.1	RF	RETAINER: Tit type; fuse clip 31-60, 250-v H. B. Sherman.	2					*
301	3Z7025-13	I	RHEOSTAT: 25-ohm ±10%; type H, Ohmite.	1	*				*
	2Z8051-7	I	ROD: h-v res; phenolic; 3/4″ OD x 1-3/8″, threaded; ES-827115-2, WE.	1	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	2Z8051-8	I	ROD: h-v res; phenolic; 9/16″ OD x 1-3/8″ lg, threaded; ES-827115-3, WE.	1	*				*
163	3H402-1/W5	M RF	ROTOR: for blower; 24-blade wheel; KS-5992, L22, WE Co.	2					*
	6L6440-4.49S	AD	SCREW: machine; RHS; 4-40 thd, 1/4″ lg; cadmium-plated.	1	*				*
	6L6440-8.1Z	ACC	SCREW: machine; RHS; 4-40 thd, 1/2″ lg; zinc-plated.		*				*
	6L6632-8.49S	M RF	SCREW: RHM; No. 6 (0.138)-32 x 1/2″.	14	*				*
	6L6632-12.49S	RF	SCREW: machine; RHI; 4-32, 3/4″ lg; cadmium-plated.	9	*				*
	6L6632-16.49S	AD	SCREW: RHM; No. 6 (0.138)-32 x 1″.	1	*				*
	6L6832-4.49S	AD	SCREW: RHM; No. 8 (0.164)-32 x 1/4″.		*				*
	6L6832-8.49S	M RF C AD	SCREW: RHM; No. 8 (0.164)-32 x 1/2″.	25	*				*
	6L6832-12.49S	M RF AD	SCREW: RHM; No. 8 (0.164)-32 x 3/4″.	14	*				*
	6L7032-8.49S	M RF AD	SCREW: RHM; No. 10 (0.190)-32 x 1/2″.	15	*				*
	6L7920-4-10.49S	RF	SCREW: machine; RHS; 1/4-20 thd, 5/8″ lg; zinc- or cadmium-plated.	17	*				*
	6L7920-4-14.49S	RF AD	SCREW: RHM; 1/4″ (0.250)-20 x 7/8″.	4	*				*

	6L18204-4.1	AD	SCREW: self-tapping; RHS; No. 4, 1/4″ lg; Parker-Kalon, type Z.	94	*				*
	6L18204-8.1	AD	SCREW: self-tapping; RHS; No. 4, 1/2″ lg; Parker-Kalon, type Z.	31	*				*
	6L18206-8.49S	M RF AD	SCREW: self-tapping; round head; No. 6 (0.138) x 1/2″ (steel, chromate, or phosphate finish over zinc plate; Parker-Kalon, type Z).	12	*				*
	6L18204-8.83	AD	SCREW: self-tapping; stovehead; No. 4 (0.112) x 1/2″; (steel, chromate, or phosphate finish over zinc plate; Parker-Kalon, type Z).		*				*
	6L18206-8.83	C AD ACC	SCREW: self-tapping; stovehead; No. 6 (0.138) x 1/2″; (steel, chromate, or phosphate finish over zinc plate; Parker-Kalon, type Z).		*				*
	6L18208-8.83	AD	SCREW: self-tapping; steel; No. 8, 1/2″ lg; stovehead; Parker-Kalon, type Z.		*				*
	6Z8086	AD	SEAL: klosure; std 1.25″ OD for 5/8″ diam shaft No. 89 Garlock.	2	*				*
	6Z8087	AD	SEAL: klosure; std 1.25″ OD for 1/2″ diam shaft No. 53 Garlock.	1					*
	2S5003-1/F1	CC & FS	SHAFT: flexible; 36″ lg; connects gear box of handwheel drive to indicator unit; ES-804130-1, WE Co.	1				*	*
	2Z8201.18	AD	SHAFT ASSEMBLY: steel; WE Co ES-824131-5; (consists/cylindrical, 2-sec. steel rod fitted into each end, steel tube 40-25/32″ lg x 3/4″ diam).	1					*
	2Z8201.8	I	SHAFT ASSEMBLY: flexible; WE ES-807111-4; (steel shaft 5/8″ long x 0.248″ diam, over-all lgth 2-11/16″).	1				*	*
	2Z8201.7	I	SHAFT ASSEMBLY: flexible; WE ES-807111-5; (steel shaft 5/8″ lg x 0.248″ diam, over-all lgth 13-1/16″).	1				*	*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
	2Z8201.15	I	SHAFT ASSEMBLY: WE ES-827131-3; (3 sections; cylindrical shape; varying diam, over-all 3/8″ diam x 4″ lg).	1				*	*
	2C1565-12/S3	I	SHELL ASSEMBLY: WE ES-803931-2; (consists of tubular brass shell 4-9/32″ lg x 1-3/8″ OD, with slotted brass sleeve nut sweated in end of shell).	1					*
	3Z7702-2		SHELTER: Signal Corps type Tent S-3/TPS-1; Western Electric Co No. KS-5806, list 1.	1					*
	2C3736-1/S4	RF	SHIM: 1/8″ thk; ES-804120-8, WE Co.	6	*				*
	2C3736-1/S5	RF	SHIM: 1/16″ thk; ES-804120-7; WE Co.	6	*				*
	2Z8498-1	I	SHOCK MTG: WE ES-804122-1; (round rubber cushion 1-1/2″ diam 5/8″ high, mtd on bell-shaped steel holder having rectangular flange 2-3/8″ sq x 1-1/16″ high, connector 4-3/4″ lg, riveted to mtg).	8					*
	2C3736-1/S8	RF	SLIDE: brass; part of plunger assembly; ES-803927-1, WE Co.	2					*
110	2Z8671.38	M	SOCKET: 1-contact; WE Co D-163538; (consists of aluminum shell connected to hard rubber mtg plate).	1	*				*
504	2Z8674.21	AD	SOCKET: 4-contact; Amphenol AN-3102-18-4S; (four No. 16 socket contacts, 1/8″ spacing; 10-amp; molded low-loss insulator; split type aluminum shell; 90° angle; L-shaped; 1-15/16″ lg x 1-1/8″, coupling ring threaded 1-1/8″-18, cable end threaded 1″-20).	1	*				*
58	2Z8799-173	RF	SOCKET SO-173: [electrical connector; Army-Navy part AN-3102-20-4P per Spec AN-9534, Spec 71-1106; part of PE-89-( ) and PE-109-( )].	1	*				*

381 61	2Z8799-184	I RF	SOCKET SO-184: Spec AN-9534a; (electrical connector; box mounting receptacle; 4 No. 12, 18 No. 16 contacts; rated for 200-volt peak service; fits Plug PL-P244; Army-Navy part No. AN-3102-36-1P with Signal Corps type number on socket shell).	2	*				*
371-1 through 371-6	2Z8799-239	I	SOCKET SO-239: (female; single-contact; dwg No. SC-D-5850, for use w/PL-259, takes Socket Hood M-360 where complete shielding of cable lead is required).	6	*				*
380-1	2Z8674.20	I	SOCKET: 4-contact; Amphenol AN-3102-20-4S (conduit 3/4″ flange 1-1/2″ sq, 0.120″ diam, contacts for No. 12 AWG, coupling 1-1/4″-18 thd, 4 mtg holes).	1	*				*
	2Z8678.73	RF	SOCKET ASSEMBLY: octal; brass; WE ES-803913-2; (cylindrical; consists of FE8 Amphenol socket, mtd in brass tube, slotted 0.015″ w x 3/4″ deep, attached to frame with terminals for mtg 2 capacitors and 1 resistor).	3	*				*
	2Z8677.2	M	SOCKET: tube; 7-contact; RCA type UT 106; (wafer type; cadmium-plated contacts; glazed steatite base, aluminum shield ring extends upward 3/4″, mtg hole 2-1/4″ diam).	1	*				*
	2Z8678.16	M	SOCKET: tube; 8-prong; Cinch 9881; (over-all, 1-1/4″ x 1-25/32″ x 11/16″ thick; molded insulation; 2 mtg lugs, on opposite sides).	2	*				*
	2Z8678.71	RF	SOCKET: ferrule; 8-cont; Amphenol FE8; cat. No. 65; (octal type with bakelite base, approx 3/4″ x 1-1/8″ diam not including solder terminals).	3	*				*
443	2Z8671.4	I	SOCKET: female; Jones type S-101-1/4; (brass base).	1	*				*
	2Z5883-56	I	SOCKET ASSEMBLY: lamp; Signal Indicator Corp No. 706; (miniature bayonet type for use with any type miniature bayonet base lamp).	4	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Orgn stock		Quan per unit	3d ech	4th ech	Depot stock
				1st ech	2d ech				
442-1 442-2 442-3 442-4 442-5	2ZK8678.56	I	SOCKET: tube; 8-contact; octal base; United-Carr Fastener; Ucinite, WE No. 684279-1; (steatite insulating material; contacts silver-plated phosphor-bronze; mount in 1.172″ diam hole in chassis held by steel retainer ring).	5	*				*
	2Z8678.16	I	SOCKET: tube; 8-prong; Cinch 9881; (oval; 1-1/4″ x 1-25/32″ x 11/16″ thick; molded insulation; 2 mtg lugs, on opposite sides).	33	*				*
382	2Z8678.80	I	SOCKET: vacuum-tube; 8 silver-plated phosphor-bronze contacts; Ucinite 115046-A (elliptical-shaped metal mtg shell with 1-1/4″ steatite body projecting 3/32″ above shell).	1	*				*
	2Z8682.14	I	SOCKET: tube; 12-cont; RCA 9952; [shell type; 1.1″ x 2.219″ diam, bakelite insulation, approx 2″ OD, 9/16″ x 2.219″ collar at base, grooved with 4 keyways for A-K-870, 301-1(9934) RCA socket base clamp; RCA dwg M-426865-501].	1	*				*
	2Z8674.94	I	SOCKET: 4-prong; Amphenol SS4M; (round porcelain base, 1-1/4″ diam x 7/16″ thick, prongs extended 3/8″, to fit 1.172″, part for press wire less transmitter G-1502-A-43).	1	*				*
	2Z8654.T	I	SOCKET: tube; Amphenol type S-8TM W/No. 4 retainer ring, or Cinch No. 9862 W/No. 1018 retainer ring.	1	*				*
704	2Z8678.72	I	SOCKET ASSEMBLY: octal; brass; ES-803913-1, WE.	1	*				
113	3H4417	M	SPARK GAP: spark plug No. B41457 WE.	1					*
	2Z8879-4	I	SPRING: 5/16″ OD, 40 turns, 1-21/32″ over-all; ES-827119-4, WE.	3	*				*

	2Z8878-14	M	SPRING ASSEMBLY: dumbbell-shaped; WE Co ES-693561; (consists of sheet brass spring having two rings 1-13/16″ ID, 2-9/16″ OD at each end, neck is 5/8″ w and bent U-shaped 5/16″ w with 0.316″ diam hole).	1					*
	2Z8878-15	M	SPRING: steel; 1″ long; ES-692577-4, WE Co.	1					*
	2C3736-1/S9	RF	SPRING: copper; ES-804148-4, WE Co.	1	*				*
	2C2537-2/S2	M	SPRING ASSEMBLY: 2 bronze 1-1/2″ springs on phenolic plate x 1-1/4″ x 1/8″; ES-692582-2, WE Co.	1					*
393-1 393-2	3Z9825-66.31	I	SWITCH: rotary; WE Co dwg ESO-827003; (2-position; nonshorting type contacts).	2					*
706	3Z9849.4	I	SWITCH: toggle; DPDT; Cutler-Hammer 7402; (10-amp, 250-volt, 20-amp, 110-volt).	1					*
157	3Z9824-31.4	M	SWITCH: push-button; DPST; Hart & Hegeman 81084-BA; (3-amp, 250-volt; 6-amp, 125-volt; WE dwg ES-676800-5).	1	*				*
38	3Z9558-14	RF	SWITCH: push-button; Micro Switch Corp YZ-RQ41; (25-amp, 28.5-volt d-c; normally open contacts).	1	*				*
388	3Z9858-8.3	I	SWITCH: toggle; SPST; Arrow—Hart & Hegeman 86994-AB; (3-amp, 250-volt; 6-amp, 125-volt; Western Electric Co dwg ESO-676800-6).	1					*
389	3Z9858-8.20	I	SWITCH: toggle; DPST; Arrow—Hart & Hegeman 81024-FB; (3-amp, 250-volt; 6-amp, 125-volt, Bell Tel Lab dwg ES-676800-21).	1					*
390	3Z9558-16	I	SWITCH: push-button; Micro Switch Corp. WZ-RQ41; (25-amp, 28.5-volt, d-c; normally closed contacts).	1					*
392-1 392-2	3Z9558-15	I	SWITCH: pin plunger type; Switch Corp YZ-R31 with M7 actuator bracket less nuts; (normally open; 25-amp, 28.5-volt d-c).	2					*
391-1 through 391-3	3Z9558-14	I	SWITCH: push-button; Micro Switch Corp YZ-RQ41; (25-amp, 28.5-volt d-c; normally open contacts).	3					*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	6L994-1	AD	TAPER KEY: gib-head flat type; (1-5/16″ to 1-3/8″ shaft diam, 1-1/4″ stock lgth).	3					*
	3Z12072-13	M	TERMINAL: eyelet brass, hot-tinned; Zierick 228; (0.120″ OD x 0.128″ lg x 0.018″ thick).	1					*
	3Z12500-1.1	M	TERMINAL ASSEMBLY: WE Co ES-695619-6; (consists of red cotton-covered No. 20 AWG copper wire inserted in a No. 9 black varnished tube 5-1/2″ lg, one end of wire connected to ES-692578-2 term).	2					*
	3Z12059-35	M	TERMINAL: hot-tinned brass; Shakeproof 2585-6-1, cat. No. 42; L-shaped, each leg approx 3/8″ lg, one leg 1/8″ wide with wire hole in end, stud leg drilled for No. 6 screw.	10	*				*
	3Z12075-6	M	TERMINAL: sheet; WE Co P-216277; (13/16″ x 5/16″ brass strip, formed to approx 30° angle).	14	*				*
	3Z12075-12	M	TERMINAL: punching; WE Co 26A; 29/32″ x 9/16″ x 21/32″ over-all; two L-shaped lugs placed back to back, with insulators and terminals between each with 5/32″ mtg screw hole in base, 35/64″ between centers; two insulated terminals clamped between the two lugs each with two tinned brass soldering lugs, for mtg on relay mtg plates as extra terminals.	1	*				*
	3Z11080-3.4	I	TERMINAL: hot-tinned brass; 0.015″ thk; American Radio Hardware 2300; (pendant-shaped; flat type; 3/8″ lg, stud end hole size 3/32″ diam, wire hole opposite end 0.0635″ diam).		*				*
	2Z2600-1	I	TERMINAL: 0.015″ thick; mill-tinned copper; Zierick Mfg Corp No. 7; (0.188″ stud hole at one end and 0.070″ hole for wire at other end, approx 3/4″ long 5/16″ wide, stud end) type No. 7 with No. 6 stud hole.	9	*				*

	3Z12072-4	I	TERMINAL: sheet; Zierick 110; (0.020″ brass with tin finish, 3/8″ diam with 3/16″ x 1/2″ lug bent to angle, wire hole in end of lug, 1/4″ diam hole in round leg).	3	*				*
	3Z12072-11	M	TERMINAL: brass, tin-dipped; Zierick 129; (0.020″ thick, 0.775″ diam, stud hole 5/32″ diam, slotted hole for No. 14 wire; WE Co dwg ESX-697379, item 53; for Terminal Box JB-73 in Mount K-28-B).	4	*				*
	3Z12075-6	I	TERMINAL: sheet; WE P-216277; (13/16″ x 5/16″ brass strip, formed to approx 30° angle).	4	*				*
	3Z12075-8.1	I	TERMINAL: soldering; brass; WE P-37010; (0.0358″ thick; L-shaped; one leg 11/64″ w, 3/8″ lg, with 0.072″ hole, other leg 9/16″ w, 7/16″ lg with 0.151″ hole).	12	*				*
	3Z12500-1.2	I	TERMINAL ASSEMBLY: WE P-371196; (consists of an L-shaped terminal on a porcelain bushing with a metal covered collar; terminal is secured to top of bushing by long eyelet).		*				*
702	2Z9489.17	I	THERMOSTAT: 115-volt, 400 cycles, 1-amp, 120° F closed, 100° open; C-2851-5, Spencer.	1	*				*
	2Z10009-7	A	TRANSMISSION LINE: flexible; WE Co 807392-2; (consists of semiflexible coaxial cable 40-1/2″ lg, inner conductor 0.188″ diam, solid copper wire covered with low-loss insulation; outer conductor No. 30 AWG braided copper wire and plastic outer covering, approx 0.92″ OD equipped on each end with silver-plated brass, transformer shell assembly 2-1/8″ OD).	1					*
	2C3736-1/B3	RF	T-R BOX ASSEMBLY: WE Co ES-807757-1; (an irregular cylindrical brass casting, approx 3″ lg x 3-3/16″ diam with a bracket of half-round tubing attached parallel to the casting; over-all dimen 6-3/8″ lg x 3-3/16″ diam x 3-27/64″ high).	1					*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
359 (replaces 360 shown in fig.49)	2Z9619-70	I	TRANSFORMER: power; plate and filament; fully enclosed; oil-filled; sealed case; outside dimension 2-9/16″ x 4-9/16″ x 6-5/16″; 400 cycle; winding 1-2 115-volt, 0.35 amp; winding 3-4 6.4-volt, 0.6 amp, —1,200-volt d-c maximum to ground; winding 5-6 5,400-volt, 0.002 amp; terminal 5 working —1,300-volt d-c to ground; terminal 6 peak, 8,900-volt to ground; winding 7-8 2.6-volt, 3 amp, 5,700-volt d-c to ground; WE Co KS-9583.	1	*				*
361	2ZK9617-10	I	TRANSFORMER: filament; WE Co spec D-163352; (primary 115-volt, 400 cps; secondaries 5-volt, 4-amp; 6.3-volt, 2-amp; 5-volt, 2-amp; 6.3-volt, 5-amp; over-all dimen 2-9/16″ x approx 3-1/4″ max 2-5/8″ high, including the terminals and mounting brackets).	1	*				*
363	2Z9613.124	I	TRANSFORMER: power, WE Co D-167254; primary 115-volt, 400-cps at 0.56-amp; sec, 6.4-volt at 8-amp and 6.4-volt at 1-amp; no taps; electrostatic shield between windings ground to case; unpotted permalloy core; moisture-resistant; 3-1/4″ lg x 2-1/4″ w x 2-5/8″ high).	1	*				*
423	2C1565-12/T3	I	TRANSFORMER: coupling; WE ES-692370-4; (over-all dimen 13/16″ x 13/16″ x 1-3/8″ lg including terminals; spool-shaped; bakelite core 0.250″ diam; 2 windings impregnated with mineral wax; encased in rectangular tube with L-mtg).	1	*				*
424	2C1565-12/T1	I	TRANSFORMER: coupling; WE ES-692370-5; (over-all dimen 13/16″ x 13/16″ x 1-3/8″ long including terminals; spool-shaped; bakelite core 0.250″ diam having two windings impregnated with mineral wax, encased in rectangular tube with L-mtg).	1	*				*

425	2C1565-12/T2	I	TRANSFORMER: coupling; WE ES-692370-6; (over-all dimen 13/16″ x 13/16″ x 1-3/8″ lg including terminals; spool-shaped; bakelite core 0.250″ diam, having 2 windings impregnated with mineral wax, encased in rectangular tube with L-mtg).	1	*				*
362	2Z9613.110	I	TRANSFORMER: power; WE KS-8986; (primary 115-volt, 400-cps; with common tap No. 1, using primary tap 1-2, sec v 990 at 0.42-amp; using primary tap 1-3, sec v 875 at 0.42-amp; using primary tap 1-4, sec is 780-volt at 0.42; sec is center tapped unpotted, moistureproof; over-all dimen 3-1/4″ x 3-5/16″ x 3-1/2″ high).	1	*				*
19	2Z9621-29	RF	TRANSFORMER: auto; WE Co KS-9119; (input 115-volt at 400-cps; output delivers 106- to 121-volt in 6 steps at 5-amp, no load loss shall exceed 2.6 watts; unpotted; moisture-resistant; over-all dimen 2-1/2″ x 3-1/4″ x 2-5/8″ high).	1	*				*
11	2Z9611.98	RF	TRANSFORMER: filament; WE Co KS-8980; (primary 115-volt, 400-cps; sec 6.3-volt at 2.85-amp; all windings electrostatic alloy shielded; break-down voltage 1,500-volt, unpotted; moisture-resistant; over-all dimen 2-1/8″ x 1-3/4″ x 2-1/16″ high).	1	*				*
1	2C3736-1/T1	RF	TRANSFORMER: input; impedance ratio—50/800 - ohms, 50/950 - ohms, 50/1,100 - ohms; D-164672, WE.	1	*				*
10	2Z9611.100	RF	TRANSFORMER: mag fil, output 8-amp at 7-volt, 3.4-amp at 22-volt; KS-8983, WE.	1	*				*
119	2Z9613.113	M	TRANSFORMER: power; WE Co KS-8985; (primary 115-volt at 400-cps; sec 2.5-volt at 5-amp; 1,100-volt at 0.040-amp; 625-volt at 0.040-amp; electrostatic shield; unpotted; moistureproof case 3-1/4″ x 2-1/4″ x 3-1/2″ high).	1	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	*Signal Corps stock No.*	*Major component*	*Name of part and description*	*Quan per unit*	*Orgn stock*		*3d ech*	*4th ech*	*Depot stock*
					1st ech	*2d ech*			
120	2Z9613.112	M	TRANSFORMER: power; WE KS-8984; (primary 115-volt, 400-cps; 27-volt at 4.3-amp; 6.3-volt at 2.9-amp; 1.25-volt at 0.20-amp; electrostatic shield; unpotted; moistureproof, over-all dimen 2-9/16″ x 3-1/4″ x 2-5/8″ high).	1	*				*
73	2V1B23	RF	TUBE: vacuum; 1B23.	1	*				*
105-1 105-2	2J5D21	M	TUBE: vacuum; 5D21.	2	*				*
353-1 352-2	2J0D3/VR150	I	TUBE: vacuum; VR150-30.	2	*				*
354	2V446A	I	TUBE: vacuum; GL-446A.	1	*				*
421-1 through 421-5	2J717A	I	TUBE: vacuum; 717A.	5	*				*
345	2J3B24	I	TUBE: vacuum; 3B24.	1	*				*
346	2J5CP1	I	TUBE: vacuum; 5CP1.	1	*				*
348-1 348-2	2J5U4G	I	TUBE: vacuum; 5U4G.	2	*				*
350-1 through 350-4	2J6L6G	I	TUBE: vacuum; 6L6G.	4	*				*
351-1 through 351-8	2J6SJ7	I	TUBE: vacuum; 6SJ7.	8	*				*
4	2V5J23	RF	TUBE: vacuum; 5J23; (5J21, 5J22, 5J24, or 5J25 may be used also).	1	*				*
160	2J6AG7	M	TUBE: vacuum; 6AG7.	1	*				*

71-1 71-2 71-3	2V446A	RF	TUBE: vacuum; GL-446A.	3	*				*
106-1 106-2 106-3	2J705A	M	TUBE: vacuum; 705A.	3	*				*
161	2J829	M	TUBE: vacuum; 829.	1	*				*
162	2J8016	M	TUBE: vacuum; 8016.	1	*				*
352-1 through 352-7	2J6SL7GT	I	TUBE: vacuum; 6SL7GT.	7	*				*
349	2J6X5GT/G	I	TUBE: vacuum; 6X5GT.	1	*				*
347	2J7BP7	I	TUBE: vacuum; 7BP7.	1	*				*
	3H3100A16-2/B10	AD	V-BELT: 34-1/2″ x 1/2″ O.C. 32-1/2″ x 11/32″ I.C.; type 3345, Boston Gear Works.	1	*				*
501	3H402-1	AD	VENTILATING UNIT: KS-5807, list 03, WE Co.	1	*				*
	6L70004-1Z	AD	WASHER: lock; non-tang; No. 4; (0.114).	12	*				*
	6L70006-1Z	AD ACC	WASHER: lock; non-tang; No. 6; (0.138).	18	*				*
	6LK70008	C AD ACC	WASHER: lock; non-tang; No. 8; (0.164).		*				*
	6L70010-5Z	M RF AD	WASHER: lock; non-tang; No. 10; (0.190).	41	*				*
	6L71004-7Z	AD	WASHER: lock; non-tang; 1/4″; (0.250).	20	*				*
	1B818.56	CC & FS	WIRE: No. 18 AWG; 3-conductor; stranded; Simplex type SJ; (neoprene or tyrex covered conductor with outer rubber jacket).	1					*
	1A72	CC & FS	WIRE: No. 16 AWG; bare; tinned.	4	*				*

* Indicates stock available.

74. MAINTENANCE PARTS LIST FOR RADIO SET AN/TPS-1A (contd).

Ref. symbol	Signal Corps stock No.	Major component	Name of part and description	Quan per unit	Orgn stock		3d ech	4th ech	Depot stock
					1st ech	2d ech			
	1B1316.5	A	WIRE: radio and instrument hook-up; stranded; No. 16 AWG; synthetic insulation; braided; color-coded green; per specification No. 71-1677.	15	*				*
	1A107	M RF	WIRE: No. 20; bare; tinned.	10	*				*
	1B820.59	M	WIRE: No. 20 AWG; (single, stranded; copper; vinylite insulation, covered with a glass fiber braid; has white tracer thread).	25	*				*
	1B820.23	I	WIRE: No. 20 AWG; stranded; color designation white; type KS-8640.		*				*
	1B812.25	I	WIRE: No. 12 AWG; single; stranded; tinned copper; WE Co KS-8640; (flame-resistant; glass braid).		*				*
	1B816.27	I	WIRE: No. 16 AWG; single; stranded; tinned copper; WE Co type KS-8640; (color-coded white).		*				*
	1A818.1	I	WIRE: No. 18 AWG; bare; tinned.		*				*
	1B818.60	I	WIRE: No. 18 AWG; single; stranded; tinned copper; WE Co type KS-8640; (flame-resistant; glass braid; white-brown).		*				*
	1A107	I	WIRE: No. 20 AWG; bare; tinned.		*				*
	1B820.20	I	WIRE: No. 20 AWG; WE Co KS-8912; (twisted pair; stranded; copper; color-coded white-red, white-green).		*				*
	1B820.30	I	WIRE: No. 20 AWG; stranded; color designation WH and WH-RD; shielded; type KS-8640.		*				*
	6R57400-10	M	WRENCH: short arm; hex; for No. 10, socket-head cap screw; Parker-Kalon.	1	*				*

* Indicates stock available.

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